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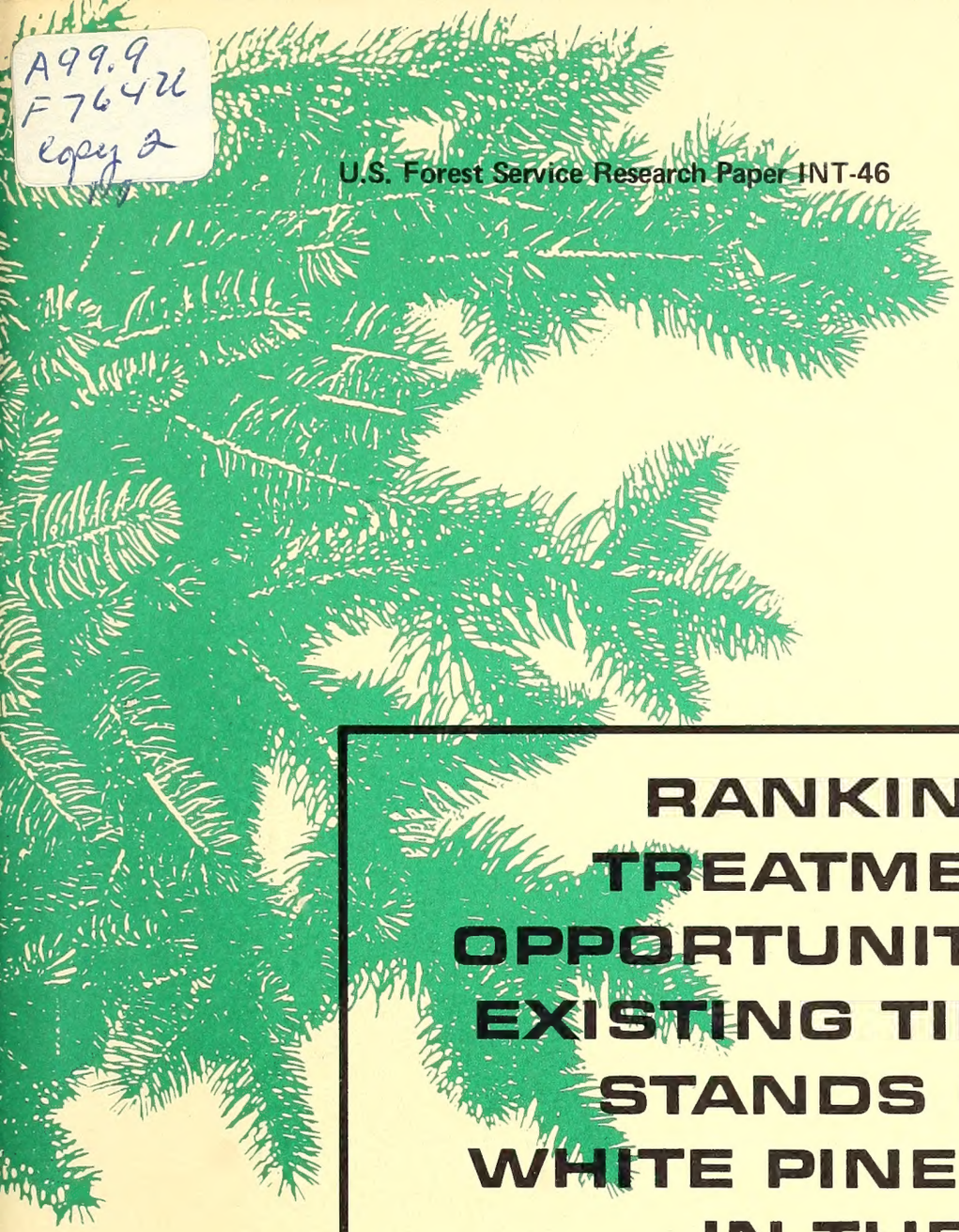

RANKING TREATMENT OPPORTUNITIES IN EXISTING TIMBER STANDS ON WHITE PINE LAND IN THE NORTHERN REGION

by

J. H. Wikstrom and Jack R. Alley

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Ogden, Utah

This is one of a series of reports published by the Intermountain Forest and Range Experiment Station. These reports are the result of a study initiated in 1962 to evaluate management alternatives on lands capable of growing white pine within National Forests in eastern Washington, northern Idaho, and western Montana. The work was done in cooperation with the Northern Region of the U.S. Forest Service. The following reports are included in the series:

Relations between western white pine site index and tree height of several associated species, by Glenn H. Deitschman and Alan W. Green. U.S. Forest Service Research Paper INT-22, 1965.

Market trends for western white pine, by Robert E. Benson and Larry L. Kirkwold. U.S. Forest Service Research Note INT-65, 1967.

Cost control in timber growing on the National Forests of the Northern Region, by J. H. Wikstrom and J. R. Alley. U.S. Forest Service Research Paper INT-42, 1967.

Evaluating species alternatives for National Forest land capable of growing western white pine, by Alan W. Green and Jack R. Alley. U.S. Forest Service Research Paper INT-43, 1967.

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CONTENTS

FOREWORD

A forest typically is made up of a large number of stands differing in stage of development, composition, and condition, and often intermingled with nonstocked areas. The task in developing action programs is to select and fit the pieces of the management puzzle together in the way that best allows the achievement of the management objective. However, before the program can evolve, or, in fact, before a realistic program objective can be developed, there must be an evaluation and ranking of the forest areas in terms of the opportunity they afford to produce specified products. This is part of the information needed for intelligent decision making.

This paper is concerned with the ranking of timber management opportunities in existing stands on National Forest land capable of producing white pine in the Forest Service's Northern Region. Presently management attention is focused on this land, partly because it is such good timber producing land and partly because the presence of blister rust in white pine has forced the Northern Region into a reevaluation of the management of white pine land. However, the evaluation techniques described here are applicable in other forest situations as well, wherever treatment alternatives exist.

INTRODUCTION

Because the Northern Region does not have an effective way to control white pine blister rust, a decision has been made to discontinue regenerating new white pine stands until rust resistant white pine planting stock is available or an economical rust control method is developed. The management problem is broader, however, than the question of what species to regenerate in place of white pine during this interim period. The white pine land[1] is largely stocked with timber, much of which is white pine. Eventually, it is hoped, the extensive research now underway will produce an effective rust control method. In the meantime the question is what to do with these stands and in what order; how to manage them in the interim period when effective control of blister rust is impossible.

This report attempts to answer the question by presenting a general method of approach to the management alternatives. The principal objective is to discuss some of the financial aspects of timber management decision making on public lands. This subject, though basic to the management of stands on white pine land, reaches beyond the problems of white pine forests.

The purpose of timber management planning on public land is, broadly speaking, threefold:

1. To produce, for a given planning period, a specified flow of timber yields consistent with both timber marketing and timber growing opportunities.

2. To select the areas best suited for producing the yields specified and to manage the selected areas in a way to achieve the most desirable balance between timber growing, recreation, watershed protection, and other forest uses.

3. To accomplish the timber growing objectives in the most economical manner possible.

A consciousness of all three aims of planning is vital to sound policy making and program development. For example, if a manager were to establish a production goal without considering rates of return possible from the forest, he might find his goal and program to be economically unrealistic. Again, if he selected for management only those stands that would individually produce the highest return on the investment, thus achieving the objective of economy, he might find it difficult if not impossible to secure the concomitant objectives of flow of yields and good coordination with other uses.

This discussion is primarily concerned with the financial ranking of stands for management treatment. Common sense dictates that all actions be considered in relation to the specified management objective, that the areas selected for timber growing be those where the objectives can be achieved at least cost, and then that the management action needed be taken in the most efficient manner possible.

Since timber management involves the expenditure of either public or private money, it is clearly desirable to choose from the available stands and management measures those that can accomplish the manager's objectives and at the same time produce the greatest dollar return on the investment. Estimations of rate of return are therefore valuable aids, and will be discussed in the following pages not as ends in themselves, but as steps in management decision making.

[1] *The term "white pine land" is used throughout this paper to designate land now growing or suitable for growing white pine. Such land is principally in Clearwater, Coeur d'Alene, Colville, Kaniksu, Kootenai, and St. Joe National Forests.*

MANAGEMENT POSSIBILITIES

Timber management possibilities in any area are limited by the capacity of the land to produce crops of wood. This capacity varies, to some extent, according to the species grown. Timber management possibilities are also limited by the nature of the stands already existing on the land. This is the primary concern of the present discussion. Land capability and species alternatives are discussed in an earlier publication in the series reporting on this study (Research Paper INT-43). They will be mentioned here only briefly.

YIELD CAPACITY OF WHITE PINE LAND

The 3.5 million acres of white pine land in the National Forests of the Northern Region includes the most productive timberland in the Rocky Mountains and is among the most productive in the United States. The white pine land of the Northern Region is now producing only a quarter to a third of the timber yields that could be realized with more intensive management. This situation exists primarily because only a portion of the forest has been converted to a regulated condition. Conversion of an old-growth forest to a condition in which the growing capacity of the land is efficiently utilized and growing stock is managed to produce a regulated flow of products is a long-term task. What can be accomplished at any one time is limited by economic circumstances and often is complicated by natural catastrophes such as fire, disease, insects, and weather. However, under management adequate to provide for prompt regeneration and stocking control the portion of this land that is site 60 or higher could produce more than 800 board feet per acre per year in an 80-year rotation. About 70 percent of land capable of growing white pine is that good.

The capacity of white pine land to produce trees is indicated in a more specific way by the data in table 1. This table shows average 10-year diameter growth rates by species for dominant and codominant trees measured on Forest Survey plots on white pine land. The growth rates shown compare favorably with growth rates in wild stands (stands that developed naturally and in which no effort has been made to control stocking) in other high timber-producing areas of the United States.

SPECIES CAPABILITIES

Even though it is not practical at this time to attempt to grow white pine on the land under study, because effective means of blister rust control are lacking, a number of other species can be grown. The most popular species that might be grown are those listed in table 1. Trees of these species now exist on the land, in some places as pure stands, but more often in stands of mixed species, often including white pine. As the growth rate data in table 1 indicate, many of the species listed grow well on white pine land.

The capacity of all the species listed to utilize the land can be influenced through management. The nature of this opportunity is partially reflected by the data in table 1. The standard deviations in growth, which are a measure of the variations in growth rates encountered, show a wide range for all species. Significantly half or more of this variation in growth can be explained by differences in stand density, tree age, and tree vigor (which is influenced by stand density), suggesting that considerable opportunity exists to improve the yield of merchantable wood through well-timed stocking control.

EXISTING STANDS

An important consideration in deciding how and when to bring a particular area or stand under management regulation is the nature of the cover already present on the

Table 1. — Average 10-year diameter growth rates by species for trees growing on white pine land

Species	Average 10-year diameter growth, all sites	Standard deviation of growth	
	Inches	*Inches*	*Percent*
White pine	2.378	1.023	43
Ponderosa pine	2.173	.821	38
Grand fir	2.131	1.003	47
Douglas-fir	1.755	.921	52
Cedar-hemlock	1.711	.864	50
Western larch	1.656	.777	47
Spruce-alpine fir	1.508	.746	49
Lodgepole pine	1.468	.782	53

Source: Forest Survey data.

land. The vegetation cover on the white pine land of the Northern Region has changed considerably in this century as a result of man's actions as well as natural factors.

Forest management started in the white pine area in the Northern Region about the turn of the century, on land supporting largely old-growth white pine timber. Since then the Forest Service has been selling timber, gradually converting the unmanaged old-growth forest to a regulated forest condition as economic limitations would permit. During this time a large volume of old-growth timber was destroyed by wildfires, disease, and insects. Today over half the forest area supports stands of sawtimber-size trees. However, sawtimber stands older than 100 years occupy only a little over a third of the area. The forest can be pictured in terms of stand size as follows:[2]

Stand size	Stand area (Thousand acres)	(Percent of total)
Sawtimber:		
Older than 160 years	586	18.2
100 to 160 years old	523	16.3
Less than 100 years old	741	23.0
Subtotal	1,850	57.5
Poletimber	620	19.2
Seedling and sapling	749	23.3
Subtotal	3,219	100.0
Nonstocked	278	
Total	3,497	

Species composition of stands varies. Although white pine is a component of many of the stands on this land today, as a result of type conversion only 12 percent of the 3.5 million acres of National Forest land capable of growing white pine actually supports stands in which white pine is the principal species. Much of this is sawtimber that can be harvested; however, as the following tabulation shows, there are 125,000 acres of white pine type containing stands of trees that are below sawtimber size:

[2] *All resource data in the tabulation were obtained from Forest Survey. All information except that presented later for young stands originating since 1949 is from surveys conducted in 1958-61. The information for the stands originating since 1949 was updated by the Northern Region from recent stand examination records and stand establishment records.*

Stand size	Thousand acres
Sawtimber	303
Poletimber	93
Seedling and sapling	32
Total	428

From even this brief description of the forest occupying white pine land, it is evident that managers hoping to improve timber production must deal with a variety of situations. Stand composition as well as stand size may vary, ranging from almost pure stands of a single species, including white pine, to stands of a variety of species mixtures. Stands may range in age from less than a year to over 200 years, and in condition from vigorous and healthy to heavily diseased and decadent. It is important to recognize also that some stands are on stable soils and gentle slopes so that they are easy to develop, whereas others are on highly unstable soils or steep slopes, or both, and may not be loggable with present technology. There is no simple answer to the management of these stands nor is there a simple solution applicable to all. *Every stand must be evaluated individually.* However, certain general considerations must be recognized with respect to white pine and other merchantable and nonmerchantable stands.

White Pine Stands

Because there is still hope for a practical method of blister rust control and research is going forward to find one, managers may wish to defer action on white pine stands if cost-value relationships would not be materially changed by a delay of a few years. This consideration would apply to mature stands as well as young stands. Again, regardless of how serious losses due to blister rust or other agents may be, it would not be wise to harvest if logging would seriously damage soil or watershed values, or both. It also may be desirable to adjust priorities in treatment planning so as to achieve yield objectives more fully.

Merchantable Stands

Some merchantable stands cannot be logged economically with present technology without undue watershed damage. However, the major consideration in dealing with merchantable stands, particularly on highly productive land, is mortality. If mortality is very light, the manager will want to defer cutting as long as possible. In stands on good land where mortality rates are high, cutting will need to be accelerated to reduce mortality losses.

Cutting for salvage in high-mortality stands appears particularly urgent in seriously threatened high-value old-growth stands of white pine. With its higher stumpage value, white pine can carry the cost of much of the access development needed to serve a multitude of land use objectives. If the white pine values are lost, large areas may have to remain without access for many years to come.

The opportunity to develop and log an area economically can be quickly lost as mortality increases. The Northern Region has about 150,000 acres of mature white pine timber type in areas largely inaccessible. Much of this timber is in stands yet to be inventoried in sufficient detail to indicate mortality, but in those stands that have been surveyed, 5 to 7 percent of white pine timber has been dying each year.

Data from the Forest Survey indicate the nature of the problem of mortality. The volume of salvable dead timber[3] reflects the more recent mortality: 38,000 acres support sawtimber stands containing 1,500 cubic feet (roughly 7,500 board feet) or more in salvable dead trees per acre, as the following tabulation shows:

Volume of salvable dead wood (Cu. ft./acre)	Approximate board feet per acre	Thousand acres
Less than 499	1,250	1,699
500-999	3,750	81
1,000-1,499	6,750	33
1,500-1,999	8,750	18
2,000-2,499	11,250	9
2,500-2,999	13,750	7
Over 3,000	15,000+	4
Total		1,851

[3] *Dead merchantable trees containing 50 percent or more sound wood at the time of measurement.*

The harvesting opportunity is limited as well by the volume of timber available per acre and by the cost of road development. In developed areas it is sometimes possible to harvest volumes of 1,000 board feet per acre or less. Data are lacking to show timber available in relation to development cost. Generally speaking, timber can be harvested if the volume available in trees of merchantable size over large areas exceeds 5,000 board feet per acre, unless problems of access and development are severe. Of the 1,850,000 acres of sawtimber in the study area, 1,633,000 acres support 5,000 board feet or more per acre.

One of the more urgent problems facing the Northern Region is to complete an inventory of white pine stands of harvestable size and determine priorities for harvesting.

Nonmerchantable Stands

The nonmerchantable stands, like the merchantable stands, represent a wide range of situations, and each stand has to be considered individually. Also, each stand has to be considered in relation to the operability and quality of the land it is growing on and in relation to the management goals set for the Forest.

Depending on their age, size, vigor, and species composition, and on the quality and character of the land on which they are growing, nonmerchantable stands present a variety of possibilities. Some may offer few management opportunities either because nature alone is doing a good job or because any improvements in the yield would be small in relation to the costs involved. In addition, some of the pure or almost pure white pine stands are so near gone that there is no alternative but to start over with a new stand of some other species or mixture of other species.

The majority of the immature stands, however, are mixed species. If these are overstocked, thinning is always a management possibility. Any diseased white pine trees in these stands can be removed in the thinning treatment.

Stands in the younger age classes (fig. 1) are generally thought to offer the best thinning opportunities, because capabilities for growth response generally decrease with age as well as with increases in stocking and loss of crown. According to surveys made in 1958-61, of the 1,368,000 acres of pole size and smaller timber, 693,000 acres supported stands that originated after 1929, and of these, 121,000 acres supported stands that originated after 1949. Since the 1958-61 survey, an additional 100,000 acres of new stands have been established on white pine land, 52,000 acres by planting and 48,000 by natural regeneration.

For the most part these stands are well stocked with potential crop trees[4] that will produce good timber products. Many of the 221,000 acres of stands originating since 1949 have already been examined to evaluate thinning opportunities, and data from these examinations suggest that most of this land is well stocked in terms of potential crop trees. These data suggest that if the stands examined are representative of the 221,000 acres, then 190,000 acres have 200 or more potential crop trees per acre, in the following proportions:

Potential crop trees per acre	Thousand acres
Less than 100	2
100 – 199	29
200 – 299	60
300 – 400	86
Over 500	44
Total	221

One of the problems of this area is that the potential crop trees are growing in competition with many trees that are excess to the needs of the stands. Some stands, principally plantations, have relatively few excess trees per acre. However, one-third of the stands that

[4] *In stand examinations, potential crop trees are identified with reference to tree quality and distribution. These are the trees that would be featured if the stand were to be thinned.*

Figure 1. – Thinning in a young stand of lodgepole pine in the Northern Region.

originated since 1949 have 1,000 or more excess trees per acre, as follows:

Excess trees per acre	Thousand acres
Less than 199	71
200 – 499	44
500 – 999	32
1,000 – 1,999	46
2,000 – 2,999	13
3,000 or more	15
Total	221

Managers may also wish to consider methods of improving wood quality yield by pruning. Pruning might help to control dwarfmistletoe, which infects some nonmerchantable stands.[5] However, the practicability of this method has yet to be demonstrated in this Region. Dwarfmistletoe might also be controlled through eradication of infected and exposed trees during the thinning process.

[5] *Flora, Donald F. A method of forecasting returns from ponderosa pine dwarfmistletoe control. U.S. Forest Serv. Res. Pap. PNW-37, 17 pp. 1966.*

Some nonmerchantable stands are residual stands of cull timber. Included in the forest on white pine land are 83,000 acres supporting stands containing 3,000 cubic feet or more per acre of cull sawtimber. Some of this land is excellent for timber production – site class 80 or better; about half is site index 60 or better:

Site class	Thousand acres
80+	10
70	12
60	17
50	23
40	21
Total	83

The site class for most of this land is based on measurement of old residual cull trees, which usually results in an underestimate of site. In many instances these cull stands can be removed inexpensively under salvage contracts, making the land available to grow a new crop. In others, it may be possible to fell and burn residual stands so that the land can be used.

CONSIDERATIONS IN RANKING TIMBER GROWING OPPORTUNITIES

Financial calculations ranking timber production opportunities are rather complex and have no utility unless performed correctly. Certain aspects of these calculations that must be thoroughly understood are discussed in the paragraphs that follow.

ALL MANAGEMENT MEASURES PLANNED SHOULD BE INCLUDED IN THE EVALUATION

It cannot be emphasized too strongly that the culturing of a crop of trees involves a number of interdependent activities. It is particularly important, therefore, that an evaluation used in comparing timber growing opportunities on different areas or pieces of land should include the entire series of treatments to be carried out. The starting point of the series varies. If the evaluation begins with the establishment of stand cutting priorities, a manager will want to rank each area on the basis of present worth, considering the existing stand and the cutting treatment, as well as all the treatments indicated to make the most of the opportunity for future timber growing. For example, it may be possible to make a greater contribution to revenue by cutting a low-volume decadent stand on high-quality land than by cutting a stand with a greater volume on a low-quality site. If the evaluation begins with regeneration, it will be advantageous to compare alternative management regimes for the entire growing period for each area, and then to compare areas on the basis of the series of treatments most favorable to each. Frequently, the manager will be interested in comparing the desirability of doing no additional management in a stand or of adding a treatment to the management program. To do this he must compare both program levels so that the cost of the management treatment added can be evaluated in relation to the increase in yield to be expected from the treatment.

Certainly a critical time for making an evaluation is when a sale is being planned. The analysis made in conjunction with timber selling should indicate first of all the order in which stands should be cut, and then how timber production on the area might proceed. For stands to be cut, the analysis should indicate whether future timber production (other than what unaided nature might accomplish) should even be considered. Such questions as these might be asked: How much could be spent on regeneration of a timber stand at the minimum interest rate specified? Could regeneration of any species be accomplished for that amount?

If timber production is planned, an analysis should be made that considers alternatives of species, silvicultural systems, and treatment combinations to determine the best way to proceed and the rate of return that would result from the best of the alternatives.

COST MUST BE CONSIDERED DISCRIMINATELY, AND IN RELATION TO THE APPROACH TO MANAGEMENT

For a useful evaluation, it is important that the cost estimates for treatments planned for a stand be as accurate as possible. Many factors influence the cost of timber growing activities and these may vary considerably from stand to stand. Ranking of stands must begin with a discriminating consideration of costs. (Timber growing costs are discussed in another publication in this series, Research Paper INT-42.)

The approach to management can have an important bearing on costs. For example, the size of the cutting blocks laid out in sales planning can have as large an effect on future timber growing costs as on the revenues realized in harvesting. As shown in table 2, when stand reestablishment involves slashing, prescribed burning, and planting, it costs

more than twice as much per acre to establish a new stand on 10-acre blocks as on 80-acre blocks.

Similarly, the way one management task is carried out can affect subsequent management actions. A minimum job of site preparation may be low in cost, but it can result in higher planting costs. The amount of debris on the ground after site preparation may even affect the cost of thinning. It is important, therefore, that costs used in financial calculations be realistic in terms of the quality of the work done and the interrelationships between the actions planned.

VALUE YIELD ESTIMATES MUST BE CONSISTENT

The problem in estimating yields is to predict how crops of trees will develop over time and how value yields will be affected by management. Also, it is necessary to estimate future wood prices.

Procedures for predicting how stands will develop under different assumptions of management are still rather crude. Computer programs have been developed for projecting stands when growth and mortality data are available, but as yet these are crude in themselves and more often than not the growth and mortality data available are inadequate.

Where stand projection programs are lacking it may be necessary to fall back on normal yield tables. These are thought to give reasonable estimates of the capacity of the land to produce wood. For example, table 3 shows the volume of wood that might be expected from fully stocked stands on white pine land for a range of ages and site classes.

Yield tables can be used for making stand projections. To illustrate, figure 2 shows the development of the average wild fully stocked stand on land in site class 60 in terms of volume in trees of different sizes. From this, some approximations can be made of the influence of stocking control. For example, assuming it is reasonable with thinning to grow stands in which all trees will be 12 inches and larger in diameter at 90 years, then AB = the volume gain at that point attributable to thinning if 12 inches (diameter) is the minimum merchantable tree size. If a series of commercial thinnings is planned, it is essential to estimate also how these are expected to influence yield.

To illustrate further, according to yield tables a fully stocked stand of western larch on site 70 land in the Northern Region should contain dominant and codominant trees averaging 70 feet in height at 50 years of age, and the stand should have a total volume of 4,682 cubic feet of wood. If the stand approaches "normal" in stocking and tree size distribution, 78 percent of the volume should be in trees 5.0 inches d.b.h. and larger and about 47 percent in trees 8 inches and larger. The Northern Region anticipates that with thin-

Table 2. — Cost of selected timber growing activities by size of area

Size of area	Activity			Total
	Slashing	Prescribed burning	Planting	
Acres	*Dollars per acre*			
10	41.00	26.00	49.50	116.50
20	30.50	23.50	35.00	89.00
40	20.00	19.00	29.00	68.00
80	12.50	13.50	25.00	51.00

Table 3. — Total volume of all trees 0.6 inch d.b.h. and larger for normal white pine stands

Age	Site index			
	50	60	70	80
	Cubic feet per acre			
40	2,270	2,650	3,030	3,400
50	3,640	4,210	4,830	5,470
60	5,050	5,880	6,710	7,600
70	6,450	7,500	8,560	9,730
80	7,750	9,000	10,350	11,750
90	8,980	10,450	12,000	13,650
100	10,100	11,850	13,500	15,400
110	11,150	13,000	14,800	16,850

Source: Haig, Irvine T. Second growth yield, stand and volume tables for the western white pine type. U.S. Dep. Agr. Tech. Bull. 323, 68 pp. 1932.

ning, fully stocked western larch stands on site 70 land should produce 4,682 cubic feet of wood at age 50 in trees 8 inches and larger and that 8-inch trees can be utilized. In other words, it is expected that an additional 2,500 cubic feet of wood per acre will be available in trees 8 inches and larger at age 50 as a result of thinning. The above information is shown graphically in figure 3.

It is well to recognize the low state of the art of projecting stands under different levels of management. However, in ranking stands for management treatment, the crudity of stand projection techniques need not be a serious handicap so long as there is no evidence of bias. It is essential only that the procedures and data used produce results that are consistent from stand to stand.

Estimating future wood prices is even more difficult than predicting stand response to treatment. No one can say definitely what wood will be worth 50 or 100 years in the future or how prices will vary between species. After studying price trends, the manager must judge what future prices are likely to be, but he must recognize that his conclusion is largely guesswork.

A recent analysis of wood selling prices (Research Note INT-65 in this series) indicates that the high prices of white pine and ponderosa pine are largely the result of the demand for the clear wood of these species. Unless stands are pruned or rotations are lengthened, the price differences between white and ponderosa pine and other species may be less in the future. It is probable that species price differences will be negligible in stands just achieving merchantable size. However, it is also probable that wood value increases with tree size in some species more than in others.

Even though species price differences have been lessening in recent years, the manager may still wish to recognize some differences in establishing prices to be used in evaluating timber growing opportunities.

Accessibility to market may be a desirable point to consider, and a range of prices by species that reflects distance from principal processing centers might be established. However, if analyses of individual stands are to be comparable, the price estimates applied to similar stands that are to be managed in the same way must be the same.

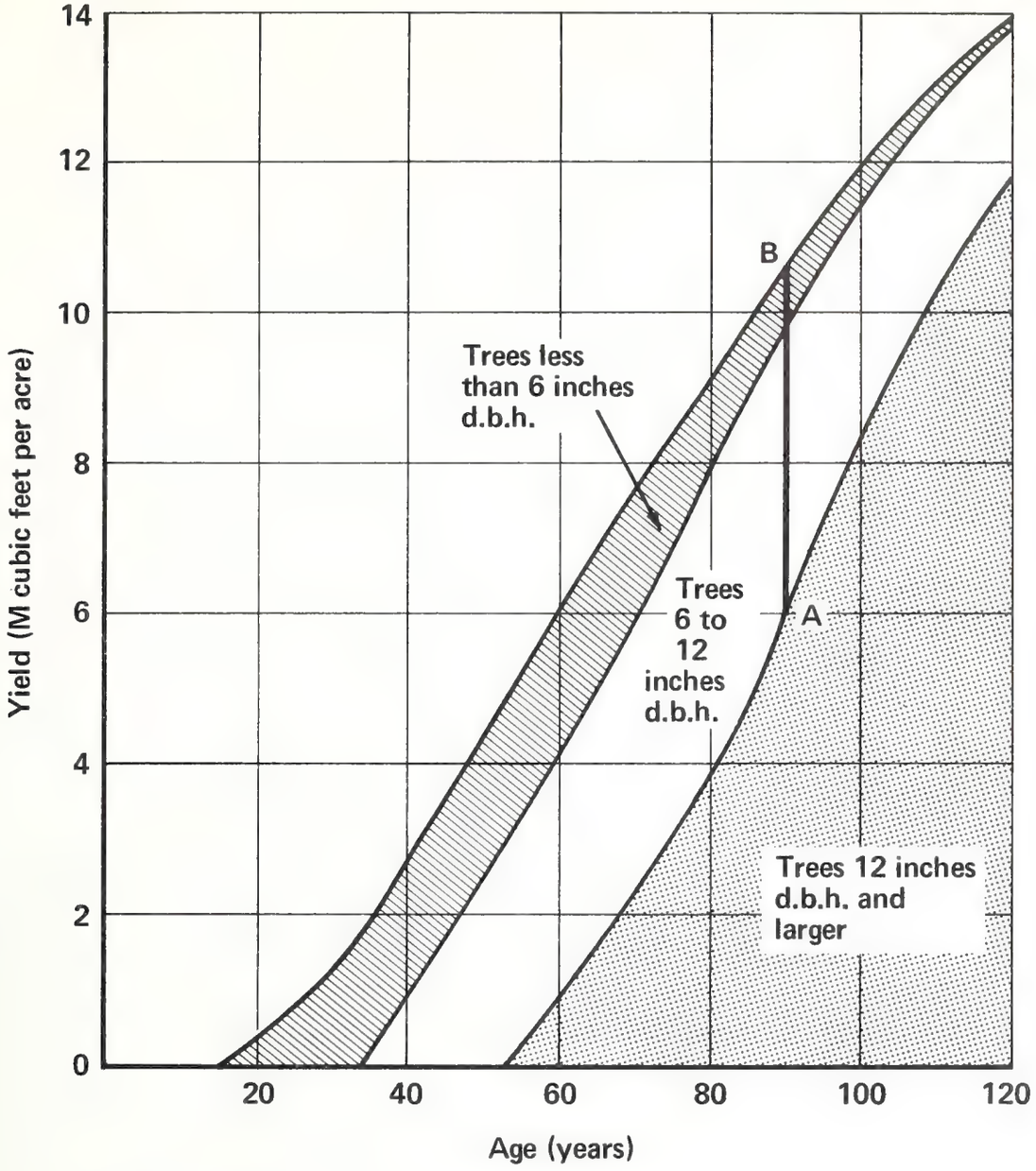

Figure 2. Volume by tree size class in fully stocked wild stands of white pine, site class 60.

TIME PERIOD ESTIMATES MUST BE CONSISTENT

Two aspects of time are important in financial calculations. First, there are the specific times when incomes are expected or expenditures are to be made. Second, there is the overall time period, the rotation planned for a timber growing operation.

Depending on the circumstances surrounding the management of a Forest, the effects of a particular management treatment may be immediate or may be realized at some later point in time. To illustrate, if the annual allowable cut were to increase immediately because of some management action, the financial calculations would be based on the net value of the increase in cut for as long as it persisted. On the other hand, if the benefits were not realized until some future date during or at the end of the rotation, the calculation of rate of return would have to take account of the elapsed time.

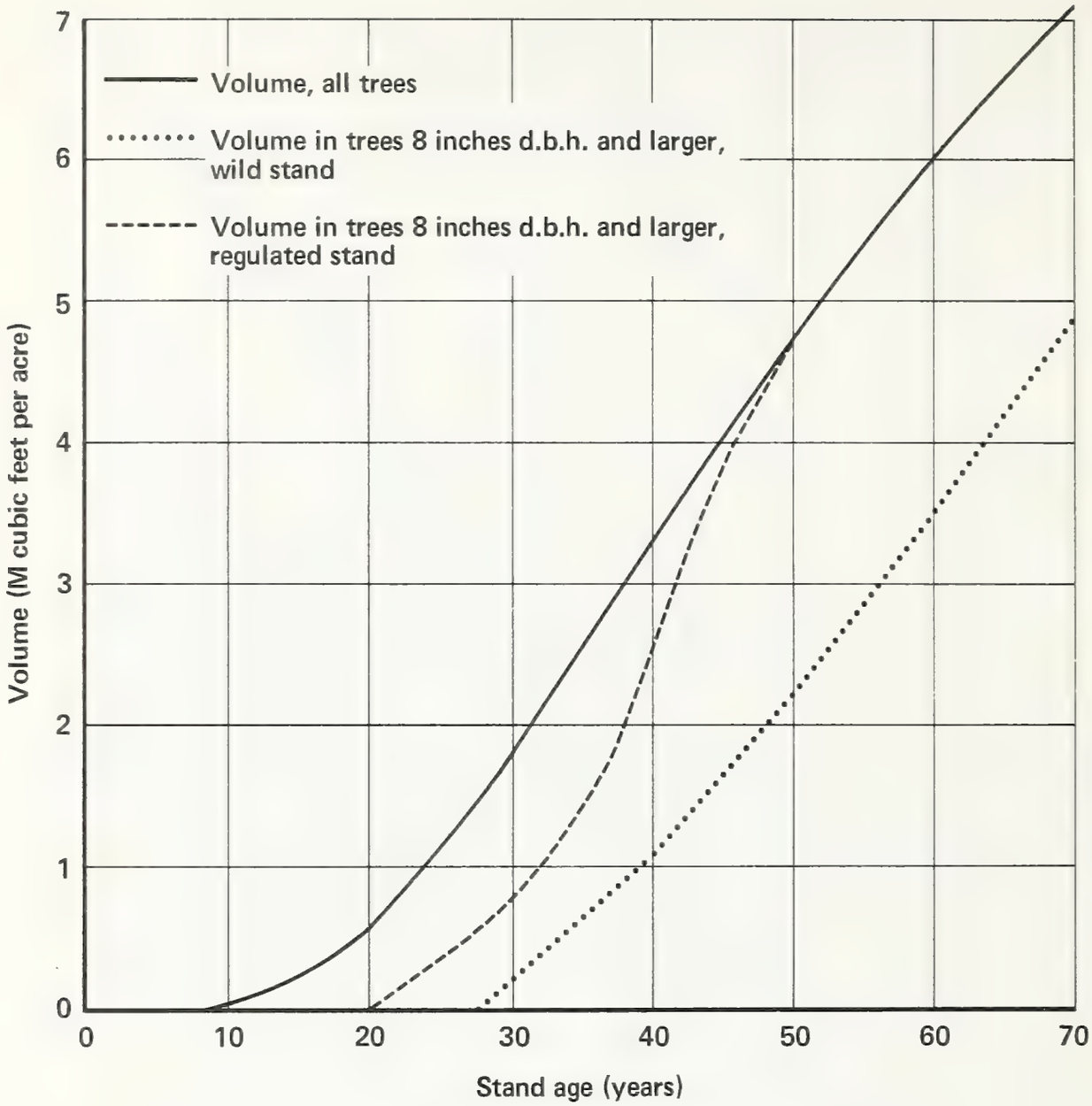

Figure 3. — Expected development of fully stocked western larch stand with and without stocking control, as represented by volume in different tree size classes.

In both situations, however, the aim is to compare the estimated cost of the management treatment being considered with the expected effect on yield, considering the time that will elapse between the point when the cost is incurred and the point when benefit is realized.

The time period or rotation used is an important element in financial calculations. However, it must be recognized here that there is a certain element of guesswork in the establishment of timber rotations. Circumstances are continually changing in a way that may affect the length of the timber growing period. Harvesting may be required short of the rotations established, to avoid serious loss due to some forest enemy. Similarly, technology or wood values may change, making either a shortening or lengthening of rotations desirable.

The Northern Region has established some tentative rotations and tree-size objectives by

site classes. These are not economic rotations in that they are not supported by economic analysis. They may be longer or shorter than is desirable from a timber growing cost-price point of view. As illustrated in table 4, on the basis of yield data for white pine (site index 70), only under the first of the two price assumptions (which were arbitrarily chosen) is the rate of value increase greater than 5 percent after age 90. The rate of value increase reflected in either set of price assumptions may or may not be reasonable.

Northern Region tentative tree-size objectives and rotations are as follows:

Site class based on height at 50 years	Average diameter (Inches)	Rotation (Years)
White pine, grand fir, spruce, hemlock		
90+	22	90
70 – 80	20	100
50 – 60	18	110
40 – 50	16	120
Larch, Douglas-fir, ponderosa pine		
90+	20	100
70 – 80	18	110
50 – 60	16	120
40 and less	Cordwood	
Lodgepole pine		
60+	16	80
40 – 50	14	100
Less than 40	Cordwood	

In the actual practice of timber growing, the rotation period tends to be indefinite. Quite probably in the future, the termination of stand growing periods will be decided as each stand takes on merchantable value. Some stands may be held for long periods to produce products to meet particular demands. Other stands may be cut as soon as they become merchantable.

Although it is desirable to have available an established scale of economically defensible timber growing periods for broad planning purposes, that question need not be dealt with here since this discussion is concerned only with the ranking of opportunities within a particular locality. In ranking stands or areas for management treatment within a Region or within a Forest, the time periods used need not represent a serious source of bias as long as they are reasonably consistent for the entire area. It is important to recognize that in evaluating long-term production opportunities such as timber growing, consistency in procedure and data is very important.

Table 4. — Rate of stand value increase under two price assumptions — yield data for white pine site index 70

Age	Volume per acre	Assumption 1			Assumption 2		
		Price per M bd. ft.	Stand value per acre	Rate of value increase	Price per M bd. ft.	Stand value per acre	Rate of value increase
	M bd.ft.	*Dollars*		*Percent*	*Dollars*		*Percent*
50	19.5	4.00	78.00	—	4.00	78.00	—
60	33.8	6.00	202.80	10.0	6.00	202.80	10.0
70	44.8	9.00	403.20	7.5	8.00	358.40	5.9
80	63.5	13.00	825.50	6.5	10.00	635.00	5.7
90	78.0	18.00	1,404.00	5.5	12.00	936.00	4.0
100	90.5	24.00	2,172.00	4.5	14.00	1,267.00	3.1
110	100.9	32.00	3,228.80	4.0	16.00	1,614.40	2.5

Source: Haig, Irvine T. Second growth yield, stand and volume tables for the western white pine type. U.S. Dep. Agr. Tech. Bull. 323, 68 pp. 1932.

RANKING STANDS FOR TREATMENT

The calculation of rate of return is quite complicated when a series of costs as well as a series of returns are involved. Computer programs have been prepared by both Hall and Row[6] for making present worth and interest rate computations. These programs have been adapted by the Intermountain Station for use on the Forest Service's Northern and Intermountain Regions' computers to handle common evaluation problems of timber growing. Basic adaptations of both Hall's and Row's programs are described by Green and Alley for use in ranking species alternatives (Research Paper INT-42 in this series). The discussion here describes another version of the Clark Row program usable in ranking opportunities in existing stands and in evaluating timber stand improvement programs. Use of the program is illustrated in brief in the pages that follow. Details of the program are presented in the Appendix.

[6] *Hall, Otis. Evaluating complex investments in forestry and other long-term enterprises using a digital computer. Purdue Univ. Res. Bull. 752, 11 pp. 1962. Row, Clark. Determining forest investment rates of return by electronic computer, U.S. Forest Serv. Res. Pap. SO-6, 13 pp. 1963.*

RANKING STANDS FOR REPLACEMENT

The program given here is identified as Intermountain Station Investment Analysis Program No. 6. (The program listing is given in the Appendix.) Among other things, this program will compute discounted net worth[7] of future crops and discounted net worth of the present and future crops combined.

There are two common uses for this feature of the program. First of all, the program can be used to determine, from a financial standpoint, which stands should be considered for immediate cutting. To illustrate, if present net worth for a stand would be increased significantly if the stand were held for another 10-year planning period, considering both the value changes in the present stand and the future growing opportunity, the manager would not want to program it for cutting now. From an economic point of view a manager might want to hold the stand described below:

[7] *Discounted net worth is the computed present net value of the area, assuming a specified rate of return.*

	Alternative 1 (cut now)	Alternative 2 (cut in 10 years)
Present stand and conversion opportunity		
Estimated merchantable volume (100 cubic feet per acre)	70	80
Quality index	.90	1.10
Future timber growing opportunity		
Site preparation year after cutting (cost, dollars per acre)	5.00	5.00
Regeneration (cost, dollars per acre)	.00	.00
Precommercial thinning 21 years after site preparation (cost, dollars per acre)	22.00	22.00
Intermediate cut 30 years after thinning (100 cubic feet per acre)	25	25

	Alternative 1 (cut now)	Alternative 2 (cut in 10 years)
Quality index for intermediate cut	.35	.35
Harvest cut 30 years after intermediate cut (100 cubic feet per acre)	90	90
Quality index for harvest cut	1.10	1.10
Price assumption		
Net price (dollars per 100 cubic feet)	5.00	5.00
Expected increase in price per year (rate)	.005	.005

Note that for both the present and the future stands the anticipated schedule of investments and yields is listed. In each case quality of yield is indicated.[8] Note also that it has been assumed that real wood prices will increase slightly in the future (0.5 percent per year). The program provides the opportunity to assign current prices to products and include an estimate of how prices are expected to change over time.

For use with the computer program, the data in the above tabulation must be prepared for computer input. (Instructions for preparing problem input are given in the Appendix.)

The problem solution is shown in figure 4. After printing the program input, the computer lists the discounted net worth of future crops. This listing also reveals the expected internal rate of return in future timber growing if the range of interest rates specified includes the rate at which present worth is $0.00.

In this case expected internal rate of return on future timber growing is between 5.6 and 5.7 percent. It is between these rates that discounted net worth becomes zero. This listing is included in the output to help the manager decide whether to consider timber growing on the area if investments are required.

The second listing shows discounted net worth for the present and future stands. This listing shows that present worth for alternative 2 is still greater than for alternative 1 at 3.5 percent rate of return. This may be considered a lower rate of return than is desirable, but because managers in this area have so much timber in need of cutting, they may want to hold this stand and fill cutting budgets from stands for which present worth was decreasing with time, assuming the same rate of return.

In addition to using the investment analysis computer program to check his judgments about what stands to consider for cutting, the manager can also use the program to establish cutting priorities among stands ready for cutting. If a manager were not forced to cut in a specific area to control the spread of some forest infection, he logically would cut in those areas where (again considering present stand value and the future timber growing opportunity) the greatest contribution to revenue could be made. Here, again, costs and values associated with both the present stand and the future stand would be considered.

The present stand and the future timber growing opportunity on two areas described in the following tabulation are used for illustration.

	Area 1	Area 2
Present stand and conversion opportunity		
Merchantable volume per acre (100 cubic feet per acre)	74	59

[8] *The quality index is the ratio of the estimated price for the specific product to the average price expected for the product.*

	Area 1	Area 2
Quality index	.90	.90
Road costs 1 year before logging (dollars per acre)	24.00	22.00
Sales cost 2 years before logging (dollars per acre)	7.00	6.00
Future timber growing opportunity		
Thinning 30 years after logging on poor land, 15 years after logging on good land (dollars per acre)	23.00	23.00
Intermediate yield 45 years after thinning on poor land, 35 years after thinning on good land (100 cubic feet per acre)	—	20.00
Quality index	—	.35
Intermediate cut 50 years after thinning (100 cubic feet per acre)	25.00	30.00
Quality index	.35	.50
Harvest yield 80 years after thinning on poor land, 66 years after thinning on good land (100 cubic feet per acre)	80.00	120.00
Quality index	.90	1.40
Price assumption		
Price (dollars per 100 cubic feet)	7.00	7.00
Expected increase in price per year (rate)	.005	.005

The problem solution is shown in figure 5. The computer lists discounted present worth of future crops for the range of interest rates specified. This listing also reveals the expected internal rate of return in future timber growing. In the case of area 1 it is between 4.8 and 4.9 percent. Between these rates, discounted net worth becomes zero. For area 2 the expected internal rate of return is much higher — between 7.4 and 7.5 percent.

The second listing shows the discounted net worth of the present and future stands. If, in ranking stands, 3.6 percent were set as the point at which stands would be cut, a manager would cut area 2 in preference to area 1 because, as this listing shows, discounted net worth is greater by $2.64. To the extent that a manager could fill his cutting budget from areas like area 2, he would defer cutting areas like area 1.

RANKING STAND IMPROVEMENT PROJECTS

Investment Analysis Program No. 6 can also be used for evaluating timber stand improvement opportunities when the manager is concerned about cost in relation to the margin of difference resulting from treatment. For example, assume a manager has a heavily overstocked 20-year old stand: if he did nothing the stand would yield a harvest cut of 6,000 cubic feet of merchantable wood (about 30,000 board feet) in 100 years (at age 120). He might wish to know what the advantage would be of precommercial thinning and pruning. With precommercial thinning he might expect two commercial thinnings, one of 1,200 cubic feet (about 5,000 board feet) in 35 years (at age 55), and one of 2,000 cubic

Figure 4. — Problem solution (see problem 4, Appendix).

PROBLEM NO. 4--SAMPLE PROBLEM--STAND REPLACEMENT--CUT NOW OR IN 10 YEARS

DISCOUNTED NET WORTH OF FUTURE CROPS

RATE	ALT-PLAN 1 (ROTATION 81)	ALT-PLAN 2 (ROTATION 81)	ALT-PLAN 0 (ROTATION 0)
1.0	579.90	579.90	
1.1	503.11	503.11	
1.2	439.82	439.82	
1.3	386.91	386.91	
1.4	342.14	342.14	
1.5	303.88	303.88	
1.6	270.90	270.90	
1.7	242.26	242.26	
1.8	217.23	217.23	
1.9	195.22	195.22	
2.0	175.78	175.78	
2.1	158.53	158.53	
2.2	143.17	143.17	
2.3	129.45	129.45	
2.4	117.14	117.14	
2.5	106.08	106.08	
2.6	96.11	96.11	
2.7	87.10	87.10	
2.8	78.95	78.95	
2.9	71.56	71.56	
3.0	64.85	64.85	
3.1	58.75	58.75	
3.2	53.19	53.19	
3.3	48.12	48.12	
3.4	43.50	43.50	
3.5	39.27	39.27	
3.6	35.41	35.41	
3.7	31.87	31.87	
3.8	28.63	28.63	
3.9	25.66	25.66	
4.0	22.94	22.94	
4.1	20.44	20.44	
4.2	18.14	18.14	
4.3	16.04	16.04	
4.4	14.10	14.10	
4.5	12.32	12.32	
4.6	10.69	10.69	
4.7	9.19	9.19	
4.8	7.81	7.81	
4.9	6.54	6.54	
5.0	5.37	5.37	
5.1	4.30	4.30	
5.2	3.31	3.31	
5.3	2.40	2.40	
5.4	1.57	1.57	
5.5	.80	.80	
5.6	.09	.09	
5.7	-0.55	-0.55	
5.8	-1.15	-1.15	
5.9	-1.69	-1.69	
6.0	-2.19	-2.19	
6.1	-2.65	-2.65	
6.2	-3.07	-3.07	
6.3	-3.46	-3.46	
6.4	-3.81	-3.81	
6.5	-4.13	-4.13	
6.6	-4.43	-4.43	
6.7	-4.70	-4.70	
6.8	-4.94	-4.94	
6.9	-5.17	-5.17	
7.0	-5.37	-5.37	

PROBLEM NO. 4--SAMPLE PROBLEM--STAND REPLACEMENT--CUT NOW OR IN 10 YEARS

DISCOUNTED NET WORTH OF PRESENT AND FUTURE CROPS

RATE	ALT-PLAN 1 (ROTATION 0)	ALT-PLAN 2 (ROTATION 10)	ALT-PLAN 0 (ROTATION 0)
1.0	894.90	943.22	
1.1	818.11	865.10	
1.2	754.82	800.41	
1.3	701.91	746.05	
1.4	657.14	699.77	
1.5	618.88	659.94	
1.6	585.90	625.33	
1.7	557.26	595.01	
1.8	532.23	568.25	
1.9	510.22	544.46	
2.0	490.78	523.20	
2.1	473.53	504.09	
2.2	458.17	486.82	
2.3	444.45	471.15	
2.4	432.14	456.86	
2.5	421.08	443.78	
2.6	411.11	431.76	
2.7	402.10	420.68	
2.8	393.95	410.42	
2.9	386.56	400.90	
3.0	379.85	392.03	
3.1	373.75	383.74	
3.2	368.19	375.99	
3.3	363.12	368.70	
3.4	358.50	361.84	
3.5	354.27	355.36	
3.6	350.41	349.23	
3.7	346.87	343.42	
3.8	343.63	337.89	
3.9	340.66	332.63	
4.0	337.94	327.61	
4.1	335.44	322.80	
4.2	333.14	318.20	
4.3	331.04	313.78	
4.4	329.10	309.52	
4.5	327.32	305.43	
4.6	325.69	301.48	
4.7	324.19	297.66	
4.8	322.81	293.97	
4.9	321.54	290.39	
5.0	320.37	286.92	
5.1	319.30	283.55	
5.2	318.31	280.27	
5.3	317.40	277.08	
5.4	316.57	273.97	
5.5	315.80	270.94	
5.6	315.09	267.97	
5.7	314.45	265.08	
5.8	313.85	262.24	
5.9	313.31	259.47	
6.0	312.81	256.75	
6.1	312.35	254.09	
6.2	311.93	251.48	
6.3	311.54	248.91	
6.4	311.19	246.39	
6.5	310.87	243.92	
6.6	310.57	241.48	
6.7	310.30	239.09	
6.8	310.06	236.73	
6.9	309.83	234.41	
7.0	309.63	232.13	

Figure 5. – Problem solution (see problem 5, Appendix).

PROBLEM NO. 5--SAMPLE PROBLEM--STAND REPLACEMENT -COMPARISON OF 2 STANDS

DISCOUNTED NET WORTH OF FUTURE CROPS

RATE	ALT-PLAN 3 (ROTATION 110)	ALT-PLAN 7 (ROTATION 81)	ALT-PLAN 0 (ROTATION 0)
1.0	413.13	1438.99	
1.1	351.73	1252.02	
1.2	301.59	1097.88	
1.3	260.11	968.96	
1.4	225.39	859.84	
1.5	196.06	766.54	
1.6	171.09	686.07	
1.7	149.70	616.15	
1.8	131.26	555.00	
1.9	115.29	501.21	
2.0	101.40	453.67	
2.1	89.27	411.45	
2.2	78.65	373.82	
2.3	69.33	340.16	
2.4	61.12	309.96	
2.5	53.88	282.78	
2.6	47.48	258.26	
2.7	41.81	236.09	
2.8	36.79	216.00	
2.9	32.34	197.76	
3.0	28.39	181.18	
3.1	24.87	166.07	
3.2	21.74	152.29	
3.3	18.96	139.71	
3.4	16.48	128.20	
3.5	14.28	117.67	
3.6	12.31	108.02	
3.7	10.56	99.17	
3.8	9.01	91.04	
3.9	7.62	83.58	
4.0	6.38	76.71	
4.1	5.28	70.40	
4.2	4.31	64.59	
4.3	3.44	59.24	
4.4	2.67	54.30	
4.5	1.99	49.76	
4.6	1.38	45.56	
4.7	.85	41.69	
4.8	.38	38.12	
4.9	-0.04	34.83	
5.0	-0.40	31.78	
5.1	-0.72	28.97	
5.2	-1.00	26.37	
5.3	-1.25	23.97	
5.4	-1.46	21.75	
5.5	-1.64	19.69	
5.6	-1.80	17.80	
5.7	-1.93	16.04	
5.8	-2.05	14.42	
5.9	-2.14	12.92	
6.0	-2.22	11.53	

PROBLEM NO. 5--SAMPLE PROBLEM--STAND REPLACEMENT -COMPARISON OF 2 STANDS

DISCOUNTED NET WORTH OF PRESENT AND FUTURE CROPS

RATE	ALT-PLAN 3 (ROTATION 3)	ALT-PLAN 7 (ROTATION 3)	ALT-PLAN 0 (ROTATION 0)
1.0	829.80	1735.34	
1.1	767.88	1549.23	
1.2	717.20	1395.89	
1.3	675.13	1267.71	
1.4	639.80	1159.26	
1.5	609.82	1066.59	
1.6	584.19	986.68	
1.7	562.09	917.27	
1.8	542.92	856.57	
1.9	526.19	803.18	
2.0	511.52	755.99	
2.1	498.59	714.07	
2.2	487.14	676.70	
2.3	476.97	643.24	
2.4	467.89	613.20	
2.5	459.76	586.13	
2.6	452.46	561.69	
2.7	445.88	539.55	
2.8	439.92	519.45	
2.9	434.52	501.17	
3.0	429.60	484.50	
3.1	425.11	469.28	
3.2	420.99	455.35	
3.3	417.21	442.58	
3.4	413.73	430.86	
3.5	410.50	420.08	
3.6	407.51	410.15	
3.7	404.73	401.00	
3.8	402.14	392.54	
3.9	399.71	384.73	
4.0	397.42	377.48	
4.1	395.27	370.77	
4.2	393.24	364.54	
4.3	391.31	358.74	
4.4	389.47	353.35	
4.5	387.72	348.32	
4.6	386.05	343.63	
4.7	384.45	339.24	
4.8	382.90	335.14	
4.9	381.42	331.30	
5.0	379.98	327.69	
5.1	378.58	324.30	
5.2	377.23	321.12	
5.3	375.92	318.12	
5.4	374.63	315.28	
5.5	373.38	312.61	
5.6	372.15	310.08	
5.7	370.95	307.69	
5.8	369.77	305.42	
5.9	368.62	303.26	
6.0	367.48	301.21	

6.1	-2.28	10.25
6.2	-2.33	9.06
6.3	-2.37	7.96
6.4	-2.40	6.95
6.5	-2.42	6.01
6.6	-2.43	5.14
6.7	-2.43	4.34
6.8	-2.43	3.60
6.9	-2.42	2.92
7.0	-2.41	2.29
7.1	-2.39	1.71
7.2	-2.37	1.17
7.3	-2.34	.68
7.4	-2.32	.22
7.5	-2.29	-0.20
7.6	-2.25	-0.59
7.7	-2.22	-0.94
7.8	-2.18	-1.27
7.9	-2.15	-1.57
8.0	-2.11	-1.84
8.1	-2.07	-2.10
8.2	-2.03	-2.33
8.3	-1.99	-2.54
8.4	-1.96	-2.73
8.5	-1.92	-2.91
8.6	-1.88	-3.07
8.7	-1.84	-3.21
8.8	-1.80	-3.34
8.9	-1.76	-3.46
9.0	-1.72	-3.57
9.1	-1.68	-3.66
9.2	-1.64	-3.75
9.3	-1.61	-3.82
9.4	-1.57	-3.89
9.5	-1.53	-3.95
9.6	-1.50	-4.00
9.7	-1.46	-4.04
9.8	-1.43	-4.08
9.9	-1.39	-4.11
10.0	-1.36	-4.14

6.1	366.35	299.25
6.2	365.24	297.39
6.3	364.15	295.61
6.4	363.07	293.91
6.5	362.00	292.27
6.6	360.94	290.71
6.7	359.89	289.20
6.8	358.85	287.76
6.9	357.82	286.36
7.0	356.80	285.02
7.1	355.78	283.72
7.2	354.77	282.46
7.3	353.77	281.24
7.4	352.77	280.06
7.5	351.78	278.91
7.6	350.80	277.80
7.7	349.82	276.71
7.8	348.84	275.65
7.9	347.87	274.62
8.0	346.90	273.61
8.1	345.94	272.63
8.2	344.98	271.66
8.3	344.03	270.72
8.4	343.08	269.79
8.5	342.13	268.88
8.6	341.18	267.98
8.7	340.24	267.11
8.8	339.31	266.24
8.9	338.37	265.39
9.0	337.44	264.55
9.1	336.51	263.72
9.2	335.59	262.91
9.3	334.67	262.10
9.4	333.75	261.31
9.5	332.83	260.52
9.6	331.92	259.74
9.7	331.01	258.97
9.8	330.10	258.21
9.9	329.20	257.46
10.0	328.30	256.71

feet (about 10,000 board feet) in 55 years (at age 75), and a harvest cut of 11,000 cubic feet (70,000 board feet) in 80 years (at age 100). It is estimated that with pruning the value of the harvest cut would be increased 65 percent. The costs and yields are summarized as follows:

Costs	No management			With management		
				(Dollars)		
Thinning		—			26.00	
Pruning		—			30.00	
Yields	**Age**	**Volume (M bd.ft.)**	**Quality index**	**Year**	**Volume (M bd.ft.)**	**Quality index**
1st thinning	—	—	—	35	5	0.20
2nd thinning						
Without pruning	—	—	—	55	10	.80
With pruning	—	—	—	55	10	.85
Harvest						
Without pruning	100	30.0	.90	80	70	1.10
With pruning	—	—	—	80	70	1.75

Basic stumpage price = $10 per thousand board feet changing at the rate of 0.5 percent per year.

The questions the manager would want answered are (1) What will the additional merchantable yield resulting from thinning mean in terms of rate of return – in other words, what would be the rate of return on the added expenditure required to do the thinning? and (2) Would the value that could be added by pruning be sufficient to justify the expenditure?

The manager could work the problem out by hand, or he could describe his plans in such a way that they could be submitted for solution by computer. For example, in one comparison a timber growing program requiring thinning only can be compared with a timber growing program requiring no cultural work. A second comparison can be made between a timber growing program that includes both thinning and pruning with one requiring no cultural work.

Figure 6 shows the output and illustrates the nature of the machine calculation. Present discounted net worth for each timber growing program, in the comparisons for the range of interest rates specified, is shown first. The program then computes the present discounted net worth of the difference due to the added treatment for the range of interest rates specified. The interest rate shown at the point where present worth of the difference changes from a positive to a negative value is the rate earned. In the case of thinning compared with a plan of management that did not include thinning, the rate of return on the input for thinning is between 5.2 and 5.3 percent. The input for thinning and pruning in the second comparison would earn between 4.5 and 4.6 percent indicating that pruning only lessened the financial value of the timber growing opportunity.

Figure 6. — Problem solution (see problem 6, Appendix).

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH--FIRST TSI PLAN

RATE	ALT_PLAN 1 (ROTATION 100)	ALT_PLAN 2 (ROTATION 100)	ALT_PLAN 0 (ROTATION 0)
1.0	149.73	149.73	
1.1	135.62	135.62	
1.2	122.86	122.86	
1.3	111.30	111.30	
1.4	100.85	100.85	
1.5	91.38	91.38	
1.6	82.81	82.81	
1.7	75.05	75.05	
1.8	68.03	68.03	
1.9	61.66	61.66	
2.0	55.90	55.90	
2.1	50.69	50.69	
2.2	45.96	45.96	
2.3	41.68	41.68	
2.4	37.80	37.80	
2.5	34.28	34.28	
2.6	31.10	31.10	
2.7	28.21	28.21	
2.8	25.59	25.59	
2.9	23.22	23.22	
3.0	21.07	21.07	
3.1	19.12	19.12	
3.2	17.36	17.36	
3.3	15.76	15.76	
3.4	14.30	14.30	
3.5	12.98	12.98	
3.6	11.79	11.79	
3.7	10.70	10.70	
3.8	9.72	9.72	
3.9	8.83	8.83	
4.0	8.02	8.02	
4.1	7.28	7.28	
4.2	6.62	6.62	
4.3	6.01	6.01	
4.4	5.46	5.46	
4.5	4.96	4.96	
4.6	4.51	4.51	
4.7	4.10	4.10	
4.8	3.73	3.73	
4.9	3.39	3.39	
5.0	3.08	3.08	
5.1	2.80	2.80	
5.2	2.55	2.55	
5.3	2.32	2.32	
5.4	2.11	2.11	
5.5	1.92	1.92	
5.6	1.74	1.74	
5.7	1.58	1.58	
5.8	1.44	1.44	
5.9	1.31	1.31	
6.0	1.19	1.19	
6.1	1.09	1.09	
6.2	.99	.99	
6.3	.90	.90	

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH--FIRST TSI PLAN

RATE	ALT_PLAN 1 (ROTATION 100)	ALT_PLAN 2 (ROTATION 100)	ALT_PLAN 0 (ROTATION 0)
6.4	.82	.82	
6.5	.75	.75	
6.6	.68	.68	
6.7	.62	.62	
6.8	.56	.56	
6.9	.51	.51	
7.0	.47	.47	
7.1	.43	.43	
7.2	.39	.39	
7.3	.35	.35	
7.4	.32	.32	
7.5	.29	.29	
7.6	.27	.27	
7.7	.24	.24	
7.8	.22	.22	
7.9	.20	.20	
8.0	.18	.18	
8.1	.17	.17	
8.2	.15	.15	
8.3	.14	.14	
8.4	.13	.13	
8.5	.12	.12	
8.6	.11	.11	
8.7	.10	.10	
8.8	.09	.09	
8.9	.08	.08	
9.0	.07	.07	
9.1	.07	.07	
9.2	.06	.06	
9.3	.06	.06	
9.4	.05	.05	
9.5	.05	.05	
9.6	.04	.04	
9.7	.04	.04	
9.8	.04	.04	
9.9	.03	.03	
10.0	.03	.03	

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH--SECOND TSI PLAN

RATE	ALT-PLAN 1 (ROTATION 80)	ALT-PLAN 2 (ROTATION 80)	ALT-PLAN 0 (ROTATION 0)
1.0	540.05	794.88	
1.1	499.20	732.18	
1.2	461.40	674.20	
1.3	426.41	620.60	
1.4	394.01	571.02	
1.5	364.01	525.17	
1.6	336.23	482.75	
1.7	310.50	443.51	
1.8	286.67	407.21	
1.9	264.58	373.61	
2.0	244.12	342.51	
2.1	225.15	313.73	
2.2	207.57	287.09	
2.3	191.27	262.41	
2.4	176.15	239.57	
2.5	162.13	218.41	
2.6	149.12	198.81	
2.7	137.06	180.66	
2.8	125.86	163.84	
2.9	115.47	148.25	
3.0	105.82	133.80	
3.1	96.86	120.41	
3.2	88.54	108.00	
3.3	80.81	96.49	
3.4	73.63	85.81	
3.5	66.96	75.91	
3.6	60.76	66.73	
3.7	54.99	58.21	
3.8	49.63	50.30	
3.9	44.65	42.96	
4.0	40.01	36.15	
4.1	35.69	29.83	
4.2	31.68	23.95	
4.3	27.94	18.50	
4.4	24.46	13.43	
4.5	21.22	8.73	
4.6	18.20	4.36	
4.7	15.39	.29	
4.8	12.77	-3.49	
4.9	10.32	-7.00	
5.0	8.05	-10.26	
5.1	5.92	-13.30	
5.2	3.94	-16.13	
5.3	2.09	-18.76	
5.4	.36	-21.20	
5.5	-1.25	-23.48	
5.6	-2.76	-25.60	
5.7	-4.16	-27.57	
5.8	-5.47	-29.41	
5.9	-6.70	-31.12	
6.0	-7.85	-32.72	
6.1	-8.92	-34.20	
6.2	-9.93	-35.59	
6.3	-10.87	-36.88	

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH--SECOND TSI PLAN

RATE	ALT-PLAN 1 (ROTATION 80)	ALT-PLAN 2 (ROTATION 80)	ALT-PLAN 0 (ROTATION 0)
6.4	-11.75	-38.09	
6.5	-12.57	-39.21	
6.6	-13.34	-40.26	
6.7	-14.07	-41.24	
6.8	-14.74	-42.15	
6.9	-15.38	-43.01	
7.0	-15.97	-43.80	
7.1	-16.53	-44.55	
7.2	-17.05	-45.24	
7.3	-17.55	-45.89	
7.4	-18.01	-46.50	
7.5	-18.44	-47.07	
7.6	-18.85	-47.60	
7.7	-19.23	-48.09	
7.8	-19.59	-48.56	
7.9	-19.93	-49.00	
8.0	-20.25	-49.40	
8.1	-20.55	-49.78	
8.2	-20.83	-50.14	
8.3	-21.10	-50.48	
8.4	-21.35	-50.79	
8.5	-21.58	-51.09	
8.6	-21.81	-51.36	
8.7	-22.02	-51.62	
8.8	-22.21	-51.86	
8.9	-22.40	-52.09	
9.0	-22.58	-52.31	
9.1	-22.74	-52.51	
9.2	-22.90	-52.70	
9.3	-23.05	-52.88	
9.4	-23.19	-53.04	
9.5	-23.32	-53.20	
9.6	-23.45	-53.35	
9.7	-23.57	-53.49	
9.8	-23.68	-53.62	
9.9	-23.79	-53.74	
10.0	-23.89	-53.86	

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH OF ADDED TSI INVESTMENT

RATE	ALT-PLAN 1 (ROTATION 80)	ALT-PLAN 2 (ROTATION 80)	ALT-PLAN 0 (ROTATION 0)
1.0	390.32	645.15	
1.1	363.58	596.55	
1.2	338.54	551.34	
1.3	315.10	509.29	
1.4	293.16	470.17	
1.5	272.63	433.79	
1.6	253.42	399.94	
1.7	235.45	368.46	
1.8	218.64	339.18	
1.9	202.92	311.94	
2.0	188.22	286.61	
2.1	174.47	263.05	
2.2	161.61	241.13	
2.3	149.59	220.74	
2.4	138.35	201.77	
2.5	127.85	184.13	
2.6	118.03	167.72	
2.7	108.85	152.45	
2.8	100.26	138.24	
2.9	92.24	125.03	
3.0	84.74	112.73	
3.1	77.73	101.29	
3.2	71.18	90.64	
3.3	65.05	80.73	
3.4	59.33	71.51	
3.5	53.97	62.93	
3.6	48.97	54.94	
3.7	44.29	47.50	
3.8	39.91	40.58	
3.9	35.82	34.13	
4.0	31.99	28.13	
4.1	28.41	22.54	
4.2	25.06	17.34	
4.3	21.93	12.49	
4.4	19.00	7.97	
4.5	16.26	3.76	
4.6	13.69	-0.16	
4.7	11.29	-3.81	
4.8	9.04	-7.21	
4.9	6.94	-10.39	
5.0	4.97	-13.34	
5.1	3.12	-16.10	
5.2	1.39	-18.67	
5.3	-0.23	-21.07	
5.4	-1.74	-23.31	
5.5	-3.16	-25.39	
5.6	-4.50	-27.34	
5.7	-5.75	-29.16	
5.8	-6.92	-30.85	
5.9	-8.01	-32.43	
6.0	-9.04	-33.91	
6.1	-10.01	-35.29	
6.2	-10.92	-36.58	
6.3	-11.77	-37.78	

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH OF ADDED TSI INVESTMENT

RATE	ALT-PLAN 1 (ROTATION 80)	ALT-PLAN 2 (ROTATION 80)	ALT-PLAN 0 (ROTATION 0)
6.4	-12.57	-38.91	
6.5	-13.32	-39.96	
6.6	-14.02	-40.94	
6.7	-14.68	-41.86	
6.8	-15.31	-42.72	
6.9	-15.89	-43.52	
7.0	-16.44	-44.27	
7.1	-16.96	-44.97	
7.2	-17.44	-45.63	
7.3	-17.90	-46.24	
7.4	-18.33	-46.82	
7.5	-18.73	-47.36	
7.6	-19.12	-47.86	
7.7	-19.48	-48.34	
7.8	-19.81	-48.78	
7.9	-20.13	-49.20	
8.0	-20.43	-49.59	
8.1	-20.72	-49.95	
8.2	-20.98	-50.30	
8.3	-21.24	-50.62	
8.4	-21.47	-50.92	
8.5	-21.70	-51.20	
8.6	-21.91	-51.47	
8.7	-22.11	-51.72	
8.8	-22.30	-51.95	
8.9	-22.48	-52.17	
9.0	-22.65	-52.38	
9.1	-22.81	-52.58	
9.2	-22.96	-52.76	
9.3	-23.11	-52.93	
9.4	-23.24	-53.09	
9.5	-23.37	-53.25	
9.6	-23.49	-53.39	
9.7	-23.61	-53.53	
9.8	-23.72	-53.65	
9.9	-23.82	-53.77	
10.0	-23.92	-53.89	

APPENDIX

INVESTMENT ANALYSIS PROGRAM NO. 6

This program is a modification of the program prepared originally by Clark Row[9] and later revised by Robert Marty et al.[10] The basic changes made in this version of the program are as follows:

1. Change in input requirements so that periodic and annual incomes can be handled in addition to periodic and annual costs. Cost items are identified in the input with a minus sign (-) preceding the amount of the cost. Final value, treated as a separate item in the original program, is handled as a periodic income in this version of the program.

2. Change in input requirements so that the program can be used with and without product evaluations. That is, if only periodic costs and incomes are involved, the only control cards needed are those associated with periodic costs. If both periodic and annual costs and incomes are included in the problem, only those control cards associated with periodic and annual costs and incomes are required. If product evaluations are included in the problem, additional control cards are required.

3. Addition of an option for evaluating timber stand replacement priorities. This option requires two sets of control cards: one set shows costs and incomes associated with the future timber growing opportunity; a second set shows costs and incomes associated with the present stand conversion opportunity. The future timber growing opportunity and the present stand conversion opportunity are evaluated separately and then together.

4. Addition of an option for evaluating timber stand improvement (TSI) programs. This option is used to evaluate timber stand improvement program levels and is particularly useful where the program differences to be evaluated affect the yield in a complex way. For example, the inclusion of thinning in the timber growing program may affect the quality, quantity, and timing of intermediate cuts as well as the final cut.

Two sets of control cards are used: one describes the minimum program considered, and a second describes the program with one or more other timber practices included. Each of the programs is evaluated separately and then the effect of the practices added is evaluated.

INPUT REQUIREMENTS IN BRIEF

Up to 15 different cards or card types (groups of repeated cards) are used, depending on the nature of the problem and the way the program is being used. Whenever the program is used to evaluate stand replacement or timber stand improvement programs, cards or card types 7 through 13 are repeated as needed to form the second set of control cards mentioned above.

These 15 different cards or card types may also be grouped into four classes.

CLASS I includes cards 1, 2, and 3. These are used to identify the program user and are required only with the first problem when a user is submitting a number of problems.

CLASS II includes cards 4, 6, and 7 (and 5 where used), which are problem descriptions and general control cards required with every problem.

[9] *Row, Clark. Determining forest investment rates of return by electronic computer. U.S. Forest Serv. Res. Pap. SO-6, 13 pp. 1963.*

[10] *Marty, Robert, Charles Rendt, and John Fedkiw. A guide for evaluating reforestation and stand improvement projects in timber management on the National Forests. U.S. Dep. Agr., Agr. Handbook 304, 24 pp. 1966.*

CLASS III includes cards or card types 8, 9, 10, 11, 12, and 13. These are used only as needed to enter cost, income, product, and price information.

CLASS IV includes cards 14 and 15, which are problem termination cards. Card 14 is always required. Card 15 is required when the problem of another user is to be entered.

CONTROL CARD FUNCTIONS

Class I Cards

(Required with the first problem in each series of problems submitted)

Card 1. Name of National Forest or organization. – This card, with cards 2 and 3, puts the name of the user and his organization into the computer so that they can be printed on the output to facilitate identification and handling.

Card 2. Name of unit or branch.

Card 3. Name of user.

Class II Cards

(Required for every problem)

Card 4. Number and/or name of problem and number of descriptive cards. – This card puts the problem identification into the computer for use as a label on output information.

Card 5. This card type is used to put into the computer additional descriptive information that the user wants to have on the output. – For example, if two or more alternatives are being compared, the user may wish to include a description of each alternative on the computer output.

Card 6. Interest rates and program and output options. – This program utilizes the iteration procedure of calculation; that is, the user specifies the minimum and maximum interest rates he will consider, and the increment of change the computer is to use. Also the program permits three options:

1. A general option for computing internal rate of return and present worth at specified interest rates.
2. An option to evaluate timber stand replacement opportunities.
3. An option to evaluate timber stand improvement opportunities.

The above are specified on the 6th card.

Card 7. General problem control card. – This card describes the details of the problem to the computer. Nine types of information are included on this card:

1. The number of alternatives or plans to be evaluated. The program will handle up to six alternatives or plans at once, provided they utilize the same program and output options (specified on card 6). This information type tells the computer how many alternatives or plans are included in the problem.
2. Numbers identifying each alternative or plan to be evaluated.
3. The time period (rotation) specified for each plan.
4. If product evaluations are included, the maximum number of products (0-3) in any alternative or plan for which dollar yield must be figured.
5. If periodic costs and incomes are included, the maximum number and the number in each plan or alternative.
6. If annual costs are included, the maximum number and the number in each plan or alternative.
7. The type of terminal calculation the computer is to use for each plan or alternative (that is, a perpetual series or a terminating series).
8. More specific instructions if the problem involves the evaluation of stand replacement or a comparison of TSI programs.
9. The number of sets of product prices, if product evaluations are included in the problem, so that the problem can be repeated under all the price assumptions specified.

Class III Cards

(Used only as needed)

Card 8. Periodic costs and incomes. – This *card type* is used whenever periodic costs and

incomes are included in any of the alternatives or plans in the problem, and it can be repeated as many times as needed (maximum 99) to include all periodic costs and incomes. In order to minimize the number of cards required, one periodic cost or income for each of the six possible alternatives or plans can be entered on each card. A periodic cost or income for alternative or plan 1 is entered first on the card, followed in order by one each for alternatives or plans 2, 3, 4, 5, and 6.

Card 9. Annual costs and incomes. – This *card type* is used whenever annual costs and incomes are included in any of the alternatives or plans in the problem. One card is required for each alternative or plan in which annual costs or incomes are included, and four annual costs or incomes for the particular alternative or plan can be entered on the card.

Card 10. Product evaluation control card. – This card and card types 11, 12, and 13 are used only when product evaluations are included in any of the alternatives or plans in the problem. This specific card gives the computer the following information:

1. The maximum number of product 1 returns in any alternative or plan as well as the number in each specific alternative or plan.
2. The maximum number of product 2 returns in any alternative or plan as well as the specific number in each alternative or plan.
3. The maximum number of product 3 returns in any alternative or plan as well as the specific number in each alternative or plan.

Card 11. Product names and units of measure. – This card gives the computer the names and units of measure of each product.

Card 12. Product yields. – This *card type* is used to feed product yield information into the computer; it can be repeated as necessary (maximum 99) to include all yield data. It gives the computer the year the product is harvested, and the volume and quality harvested; the product is identified from the order in which the cards are entered. Product 1 cards are entered first, followed by the cards for products 2 and 3. To minimize the number of cards required, data describing one yield for each of the six possible alternatives or plans is entered on each card *provided the data applies to the same product.* This information is entered in the same order described for card type 8.

Card 13. Product prices. – This *card type* is for feeding product price information into the computer. Each card contains a set of product prices, one for each product. Also, it gives the rate at which each product price is expected to change with time (if the rate is constant). If the problem is to be evaluated under a number of different price assumptions (maximum 9), this card can be repeated. The number of times it will be repeated is that specified in the last entry on card 7.

Class IV Cards

(Card 14 required, card 15 as needed)

Card 14. Problem termination card. – This card is required with every problem. It tells the computer if (1) another problem by the same user follows, (2) a problem by another user follows (card 15 is to be read), or (3) this is the last problem by this user and no other problems follow.

Card 15. NEW USER card. – This card is used *only* when a problem of another user follows. It signals the computer to read cards 1, 2, and 3 for the new user's location and identity.

INSTRUCTIONS FOR PREPARING CONTROL CARDS
INVESTMENT PROGRAM NO. 6

Card	Columns	Item	Field	Label
1	1-20	Name of Forest or organization		NAME
2	1-20	Name of unit		
3	1-20	Name of user		
4	1-76	Number and/or name of problem		
	79-80	Number of description cards (when used)	XX	ID
5	1-80	Problem description		IDEN
6	1-4	Minimum rate of interest to be considered	.XXX	RINT
	5-8	Interest rate increment	.XXX	
	9-12	Maximum rate of interest to be considered	.XXX	
	13-14	Program options 01 = General evaluation of alternatives – Computation of internal rate of return and present worth 02 = Evaluation of stand replacement alternatives 03 = For TSI planning – Computation of internal rate of return and present worth for programs compared and differences between them	XX	JPR
7	1-2	Number of alternatives or plans	XX	LX
	3-4	Number identifying alternative or plan 1	XX	LI(L)
	5-6	Number identifying alternative or plan 2	XX	
	7-8	Number identifying alternative or plan 3	XX	
	9-10	Number identifying alternative or plan 4	XX	
	11-12	Number identifying alternative or plan 5	XX	
	13-14	Number identifying alternative or plan 6	XX	
	15-17	Time period, alternative or plan 1	XXX	LY(L)
	18-20	Time period, alternative or plan 2	XXX	
	21-23	Time period, alternative or plan 3	XXX	
	24-26	Time period, alternative or plan 4	XXX	
	27-29	Time period, alternative or plan 5	XXX	
	30-32	Time period, alternative or plan 6	XXX	
	33-34	Maximum number of products in any alternative or plan (0-3)	XX	KX
	35-36	Maximum number of periodic costs or incomes in any alternative or plan	XX	KCXX

Card	Columns	Item	Field	Label
	37-38	Number of periodic costs or incomes, alternative or plan 1	XX	KCX(L)
	39-40	Number of periodic costs or incomes, alternative or plan 2	XX	
	41-42	Number of periodic costs or incomes, alternative or plan 3	XX	
	43-44	Number of periodic costs or incomes, alternative or plan 4	XX	
	45-46	Number of periodic costs or incomes, alternative or plan 5	XX	
	47-48	Number of periodic costs or incomes, alternative or plan 6	XX	
	49-50	Maximum number of annual costs or incomes in any alternative or plan	XX	JXX
	51-52	Number of annual costs or incomes, alternative or plan 1	XX	JX(L)
	53-54	Number of annual costs or incomes, alternative or plan 2	XX	
	55-56	Number of annual costs or incomes, alternative or plan 3	XX	
	57-58	Number of annual costs or incomes, alternative or plan 4	XX	
	59-60	Number of annual costs or incomes, alternative or plan 5	XX	
	61-62	Number of annual costs or incomes, alternative or plan 6	XX	
	63-64	Type of terminal calculation 00 = perpetual series for all alternatives or plans 01 = terminating series for at least 1 alternative or plan	XX	NZZ
	65-66	Type of terminal calculation, alternative or plan 1 00 = perpetual series 01 = terminating series	XX	NZ(L)
	67-68	Type of terminal calculation, alternative or plan 2	XX	
	69-70	Type of terminal calculation, alternative or plan 3	XX	
	71-72	Type of terminal calculation, alternative or plan 4	XX	

Card	Columns	Item	Field	Label
	73-74	Type of terminal calculation, alternative or plan 5	XX	
	75-76	Type of terminal calculation, alternative or plan 6	XX	
	77-78	Used only with program options 2 and 3 Option 2 01 = future stands 02 = present stands Option 3 01 = initial plan 02 = second TSI plan	XX	IST
	79-80	Number of sets of product prices (0-9)	XX	MX
8		(This card is used where KCXX (columns 35-36 on card 7) is greater than 00; it is for listing periodic costs and incomes. One cost or income for each of 6 alternatives or plans can be entered on each card. Card can be repeated 99 times. All cost items are preceded by a minus sign (-).)		
	1-3	Year of i^{th} cost or income, alternative or plan 1	XXX	NC(L,KC)
	4-12	Amount of i^{th} cost or income, alternative or plan 1	XXXXXX.XX	PECO(L,KC)
	13-15	Year of i^{th} cost or income, alternative or plan 2	XXX	
	16-24	Amount of i^{th} cost or income, alternative or plan 2	XXXXXX.XX	
	25-27	Year of i^{th} cost or income, alternative or plan 3	XXX	
	28-36	Amount of i^{th} cost or income, alternative or plan 3	XXXXXX.XX	
	37-39	Year of i^{th} cost or income, alternative or plan 4	XXX	
	40-48	Amount of i^{th} cost or income, alternative or plan 4	XXXXXX.XX	
	49-51	Year of i^{th} cost or income, alternative or plan 5	XXX	
	52-60	Amount of i^{th} cost or income, alternative or plan 5	XXXXXX.XX	
	61-63	Year of i^{th} cost or income, alternative or plan 6	XXX	
	64-72	Amount of i^{th} cost or income, alternative or plan 6	XXXXXX.XX	

Card	Columns	Item	Field	Label
9		(This card is used when JXX (columns 49-50 on card 7) is greater than 00; it is for listing annual costs or incomes. As many as 4 annual costs or incomes for an alternative or plan can be listed on 1 card. The limit is 1 card for each alternative. All cost items are preceded by a minus sign (-).)		
	1-3	Starting year of 1st annual item	XXX	NI(J)
	4-6	Terminating year of 1st annual item	XXX	NT(J)
	7-14	Amount of 1st annual item	XXXXX.XX	AN(II,J)
	15-20	Change in 1st annual item (If change is a decrease, a minus sign (-) precedes the amount)	XX.XXX	CAN(II,J)
	21-23	Starting year of 2nd annual item	XXX	
	24-26	Terminating year of 2nd annual item	XXX	
	27-34	Amount of 2nd annual item	XXXXX.XX	
	35-40	Change in 2nd annual item	XX.XXX	
	41-43	Starting year of 3rd annual item	XXX	
	44-46	Terminating year of 3rd annual item	XXX	
	47-54	Amount of 3rd annual item	XXXXX.XX	
	55-60	Change in 3rd annual item	XX.XXX	
	61-63	Starting year of 4th annual item	XXX	
	64-66	Terminating year of 4th annual item	XXX	
	67-74	Amount of 4th annual item	XXXXX.XX	
	75-80	Change in 4th annual item	XX.XXX	
		(Cards 10, 11, 12, and 13 are used only when product values are to be computed – KX (columns 33-34 on card 7) is greater than 00.)		
10	1-2	Maximum number of product 1 returns in any alternative or plan	XX	K1XX
	3-4	Number of product 1 returns, alternative or plan 1	XX	K1X(L)
	5-6	Number of product 1 returns, alternative or plan 2	XX	
	7-8	Number of product 1 returns, alternative or plan 3	XX	
	9-10	Number of product 1 returns, alternative or plan 4	XX	
	11-12	Number of product 1 returns, alternative or plan 5	XX	
	13-14	Number of product 1 returns, alternative or plan 6	XX	

Card	Columns	Item	Field	Label
	15-16	Maximum number of product 2 returns in any alternative or plan	XX	K2XX
	17-18	Number of product 2 returns, alternative or plan 1	XX	K2X(L)
	19-20	Number of product 2 returns, alternative or plan 2	XX	
	21-22	Number of product 2 returns, alternative or plan 3	XX	
	23-24	Number of product 2 returns, alternative or plan 4	XX	
	25-26	Number of product 2 returns, alternative or plan 5	XX	
	27-28	Number of product 2 returns, alternative or plan 6	XX	
	29-30	Maximum number of product 3 returns in any alternative or plan	XX	K3XX
	31-32	Number of product 3 returns, alternative or plan 1	XX	K3X(L)
	33-34	Number of product 3 returns, alternative or plan 2	XX	
	35-36	Number of product 3 returns, alternative or plan 3	XX	
	37-38	Number of product 3 returns, alternative or plan 4	XX	
	39-40	Number of product 3 returns, alternative or plan 5	XX	
	41-42	Number of product 3 returns, alternative or plan 6	XX	
11	1-20	Name and unit of measure, product 1		A
	21-40	Name and unit of measure, product 2		
	41-60	Name and unit of measure, product 3		
12	1-3	Year of j^{th} return, k^{th} product, alternative or plan 1	XXX	N1(L,K1)
	4-8	Volume of j^{th} yield, k^{th} product, alternative or plan 1	XXXXX[11]	JLD1(L,K1)
	9-12	Quality index, j^{th} yield, k^{th} product, alternative or plan 1	XXXX[12]	JUAL1(L,K1)

[11] *Decimal implied before last digit (127.3 punches 01273).*

[12] *Decimal implied before 3rd digit (1.15 punches 0115).*

Card	Columns	Item	Field	Label
	13-15	Year of j^{th} return, k^{th} product, alternative or plan 2	XXX	N2(L,K2)
	16-20	Volume of j^{th} yield, k^{th} product, alternative or plan 2	XXXXX[11]	JLD2(L,K2)
	21-24	Quality of j^{th} yield, k^{th} product, alternative or plan 2	XXXX[12]	JUAL2(L,K2)
	25-27	Year of j^{th} return, k^{th} product, alternative or plan 3	XXX	N3(L,K3)
	28-32	Volume of j^{th} yield, k^{th} product, alternative or plan 3	XXXXX[11]	JLD3(L,K3)
	33-36	Quality of j^{th} yield, k^{th} product, alternative or plan 3	XXXX[12]	JUAL3(L,K3)
	37-39	Year of j^{th} return, k^{th} product, alternative or plan 4	XXX	N4(L,K4)
	40-44	Volume of j^{th} return, k^{th} product, alternative or plan 4	XXXXX[11]	JLD4(L,K4)
	45-48	Quality of j^{th} return, k^{th} product, alternative or plan 4	XXXX[12]	JUAL4(L,K4)
	49-51	Year of j^{th} return, k^{th} product, alternative or plan 5	XXX	N5(L,K5)
	52-56	Volume of j^{th} return, k^{th} product, alternative or plan 5	XXXXX[11]	JLD5(L,K5)
	57-60	Quality of j^{th} return, k^{th} product, alternative or plan 5	XXXX[12]	JUAL5(L,K5)
	61-63	Year of j^{th} return, k^{th} product, alternative or plan 6	XXX	N6(L,K6)
	64-68	Volume of j^{th} return, k^{th} product, alternative or plan 6	XXXXX[11]	JLD6(L,K6)
	69-72	Quality of j^{th} return, k^{th} product, alternative or plan 6	XXXX[12]	JUAL6(L,K6)
	(Card 12 may be repeated 49 times if necessary to include all product returns.)			
13	1-9	i^{th} unit price assumption, product 1	XXXXX.XXX	PR1(M)
	10-18	i^{th} change in unit price, product 1	XXXXX.XXX	CPR1(M)
	19-27	i^{th} unit price assumption, product 2	XXXXX.XXX	PR2(M)
	28-36	i^{th} change in unit price, product 2	XXXXX.XXX	CPR2(M)
	37-45	i^{th} unit price assumption, product 3	XXXXX.XXX	PR3(M)

[11] *Decimal implied before last digit (127.3 punches 01273).*

[12] *Decimal implied before 3rd digit (1.15 punches 0115).*

Card	Columns	Item	Field	Label
	46-54	i^{th} change in unit price, product 3	XXXXX.XXX	CPR3(M)
	(Card 13 may be repeated 8 times if additional price assumptions are needed.)			
14	1-2	Terminal (punch 98 or 99) Punch 98 if another problem follows Punch 99 if last problem		
15	1-10	NEW FOREST – **used only** if problem that follows is from a new user		

SAMPLE PROBLEMS

Following are seven sample problems prepared as input by a single user. The data input forms for the seven problems are shown in figures 7-13.

Problem 1 illustrates use of the general evaluation option with two alternatives or plans in which only periodic costs and incomes are involved.

Problem 2 again illustrates the general option but with periodic and annual costs and incomes. The problem is treated first as a perpetuated series and second as a terminating series.

Problem 3 is the same as problem 1 but the job of figuring product yields is left to the computer.

Problem 4 illustrates use of the stand replacement option. The problem here is to evaluate the financial advantage of cutting a stand now over holding it another 10 years.

Problem 5 is another illustration of the stand replacement option, but this time two stands are compared.

Problem 6 illustrates use of the timber stand improvement (TSI) program option. Two comparisons are made: In the first a plan calling for no TSI work is compared with a plan including thinning, and in the second, a plan calling for no TSI work is compared with a plan calling for pruning in addition to thinning.

Problem 7 illustrates use of the program in timber sale planning.

A Word About the Input

Problem 1. Note that in addition to user identification and problem title and description, only seven cards are required – one card giving interest rate and program and output specifications, one card for general program control data, and five cards for periodic cost and income data.

Problem 2. This problem contains both periodic and annual costs and incomes. It requires the same type of input as problem 1 except that nine cards are required to enter all the periodic cost and income information and two cards are required to enter the annual costs.

Problem 3. This problem utilizes the product evaluation option and requires a product option control card, a card identifying the product and unit of measure, six cards to feed in product data, and a card giving product price. Note that the product control card specifies a maximum of six products, with six in alternative or plan 1 and four in alternative or plan 2. Note also that product price is expected to increase at the rate of .005 percent per year.

Problem 4. This problem, which utilizes the stand replacement option, requires one set of cards describing the future timber growing opportunity and a second set describing the present stand conversion opportunity. In this problem, which is to evaluate the financial advantage of cutting a stand now or holding it another 10 years, the future timber growing opportunity is assumed to be the same in

both cases. The second set of cards (beginning with card or card type 6 in the classification given earlier) contains the cost and income data for the present crop. In this problem it is assumed that all development is accomplished, so only the product evaluation option is utilized in the second card set. Note that in this problem the future timber growing opportunity is evaluated as a perpetual series, whereas the present stand conversion opportunity is terminated.

Problem 5. In this problem (stand replacement) two areas are compared to see which offers the best stand conversion and timber growing opportunity. One is a relatively poor piece of land supporting a stand that contains 7,400 cubic feet of usable wood. The other is an area of good land supporting a highly defective overmature stand of less usable volume.

Problem 6. This problem looks into a TSI program. In this problem even if the manager does nothing in the way of cultural work he expects a certain result. He could thin, but he needs to know what the result would be in terms of return on the thinning investment. Or, he could thin and prune. Under alternative or plan 1, thinning is compared with no cultural work. Under alternative or plan 2, a program of thinning and pruning is compared with a program involving no cultural work. Again, two card sets are required, one for each set of management assumptions being compared under the two alternatives or plans.

Problem 7. This problem is a comparison of four timber growing alternatives on a proposed sale area made in conjunction with silvicultural planning for the area. The proposed sale is on a good site capable of producing a harvest yield of 35,000 board feet per acre in 55 years or 70,000 board feet in 85 years with stocking control. Comparisons are made using both 55- and 85-year rotations.

Plan 1. Leave one seed tree group averaging one-fourth acre in size and containing 10 Mbf for every 5 acres cut. Seed tree losses in slash disposal and site preparation are expected to be 20 percent. The per-acre cost of added work required to protect seed trees in slash disposal and site preparation is estimated to be $10.00.

Plan 2. Clearcut and plant following slash disposal, with planting expected to be necessary on half the area.

Plan 3. Clearcut with natural regeneration. This plan assumes a good seed year prior to cutting.

Plan 4. Clearcut and seed, with seeding expected to be necessary on half the area.

The costs used in this problem are shown in table 5. The yields expected are shown in table 6.

Table 5. — Average costs per acre for the problem area as a whole according to activity and plan

Activity	Plan 1	Plan 2	Plan 3	Plan 4
	Dollars			
Site preparation	10.00			
Value of seed trees	20.00			
Cost of seed tree salvage sale	.40			
Cost of seed tree sale	4.00			
Planting		19.00		
Seeding				9.00
Thinning	25.00	15.00	25.00	22.00
Stage 2 surveys	.50	.50	.50	.50

Table 6. — Expected yields per acre according to type of cut and plan

Type of cut	Plan 1	Plan 2	Plan 3	Plan 4
	Thousand board feet			
Seed tree salvage	.4			
Seed tree harvest	1.6			
Harvest at age 55	28.0	35.0	31.0	31.0
Intermediate cut at age 50	8.0	10.0	9.0	9.0
Harvest cut at age 85	65.0	70.0	68.0	68.0

Figure 7. — Computer input, Problem 1.

INPUT DATA CODING FORM	UNIT	JOB DESCRIPTION	SYSTEM	PROGRAM	JOB NUMBER	DATE

FIELD DESCRIPTIONS

LINE NO.	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
1	RESEARCH							
2	PRODUCTION ECON							
3	J. H. WIKSTROM							
4	1--SAMPLE PROBLEM--PERIODIC COSTS AND INCOMES							
5	PLAN 1--1113 YEAR ROTATION							
6	PLAN 2--1100 YEAR ROTATION							
7	.02.0,.001,.04001							
8	02010202	11131110		05050505				
9	000	-3.00000	-11.00					
10	001	-15.00001	-25.00					
11	018	-35.00016	-20.00					
12	0600	97.20060	145.00					
13	1113	4561,0010	414.00					
14	98							
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

R4-6600-12b (8/66)

Figure 8. – Computer input, Problem 2.

INPUT DATA CODING FORM	UNIT	JOB DESCRIPTION	SYSTEM	PROGRAM	JOB NUMBER	DATE

FIELD DESCRIPTIONS

LINE NO.	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
1	2-1SAMPLE	PROBLEM-1-PERIODIC AND ANNUAL COSTS AND INCOMES						012
2	PLAN 1	-1-PERPETUATED SERIES						
3	PLAN 2	-1-TERMINATED SERIES						
4	.005.0011.1	0001101						
5	02011012	04004040		09090909	01101101		011	011
6	000	-25.00000						
7	000	-20.00000						
8	004	-6.00004						
9	008	-3.00008						
10	015	20.00015						
11	025	36.00025						
12	033	40.00033						
13	040	4500.00040						
14	040	25.00040						
15	0000040	-1.112						
16	0000040	-1.112						
17	98							
18								
19								
20								
21								
22								
23								
24								
25								
	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

R4-6600-12b (8/66)

Figure 9. — Computer input, Problem 3.

INPUT DATA CODING FORM	UNIT	JOB DESCRIPTION	SYSTEM	PROGRAM	JOB NUMBER	DATE
FIELD DESCRIPTIONS						

LINE NO	Columns 1–80
1	3--SAMPLE PRØBLEM--PERIØDIC CØSTS AND INCØMES AND YIELD CALCULATIØNS 01
2	SAME AS PRØBLEM 1 BUT WITH PRØDUCT YIELDS CØMPUTED BY THE MACHINE
3	.0020.0011.04001001
4	0201102 1131010 0110303013 01
5	000 -3.00000 -11.100
6	001 -115.00001 -125.100
7	018 -35.000116 -120.100
8	060604
9	SAWTIMBER--CU FT
10	0600972000600601215000050
11	0600324000500601215000070
12	0600324000701100380000050
13	1135160000601003200000070
14	1131122000050
15	1131122000070
16	0.1100
17	98
18	
19	
20	
21	
22	
23	
24	
25	

R4-6600-12b (8/66)

Figure 10. — Computer input, Problem 4.

INPUT DATA CODING FORM	UNIT	JOB DESCRIPTION	SYSTEM	PROGRAM	JOB NUMBER	DATE

FIELD DESCRIPTIONS

LINE NO	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
1	4-1-SAMPLE	PROBLEM-1-STAND REPLACEMENT-1-CUT MOW OR EN 10 YEARS						03
2	PLAN 1	-1-CUT NOW						
3	PLAN 2	-1-CUT IN 10 YEARS						
4	SAME FUTURE	TIMBER GROWING PROGRAM IN BOTH PLANS						
5	.01 10. 10 01 1. 0	7 00 20 1						
6	02 0 1 02	0 18 10 81		10 10 20 20 20 2				01 01
7	001	-5. 0 0 0 0 1	-5.10 9					
8	021	-22. 0 0 0 2 1	-22.10 9					
9	0 2 0 2 0 2							
10	SAWTIMBER-	-1 0 9 CU FT						
11	05 1 00 2 50 0 0	3 5 0 5 1 0 0 2 5 0	0 0 3 5					
12	08 1 0 0 A 0 0 0 1	1 0 0 8 1 0 0 9 0 0	1 1 1 a					
13	5.10 a	.10 9 5						
14	02 0 1 02	0 0 a a 1 0		10 1 1			01 10 1 0 1 1	02 0 1
15	a 1 0 1 0 1							
16	SAWTIMBER-	-1 10 0 CU FT						
17	0 0 a 1	7 0 a a a 9 0 0	1 1 0 0 a 8 0 0	1 1 1 a				
18	5.10 a	.0 0 5						
19	98							
20								
21								
22								
23								
24								
25								
	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 53 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

R4-6600-12b (8/66)

Figure 11. – Computer input, Problem 5.

INPUT DATA CODING FORM	UNIT	JOB DESCRIPTION	SYSTEM	PROGRAM	JOB NUMBER	DATE

FIELD DESCRIPTIONS

LINE NO	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
1	5--1--SAMPLE	PROBLEM--1--STAND REPLACEMENT--1--COMPARISON OF 2 STANDS						
2		PLAN 1--1--CUT HIGHEST VOLUME STAND ON POOR LAND						
3		PLAN 2--1--CUT LOW VOLUME STAND ON GOOD LAND						
4	.01	0.0 0 1 1. 1	0 0 0 2 0 1					
5	0 2 0 3 0 7	1 1 1 0 0 8 1		0 1 0 1 0 1 0 1				0 1 0 1
6	0 3 0	-1 2 5. 0	0 0 0 1 5	-1 2 5. 0 1 0				
7	0 2 0 2 0 2							
8	SAWTIMBER--1	0 0 CU FT						
9	0 7 5	2 0 0	3 5 0 5 0	3 0 0	1 5 0			
10	1 1 0	8 0 0	9 0 0 8 1	1 2 0 0	1 4 0			
11		7 1. 0 0		0 0 5				
12	0 2 0 3 0 7	0 0 3 0 0 3		0 1 0 2 0 2 0 2			0 1 0 1 0 1	0 2 0 1
13	0 0 1	-7 1. 0	0 0 0 1	-6 1. 0				
14	0 0 2	-2 4 1. 0	0 0 0 0 2	-2 2. 0				
15	0 1 0 1 0 1							
16	SAWTIMBER--1	0 0 CU FT						
17	0 0 3	7 4 0	9 0 0 0 3	5 9 0	9 0			
18		7 1. 0 0		0 0 5				
19	9 8							
20								
21								
22								
23								
24								
25								
	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

R4-6600-12b (8/66)

Figure 12. — Computer input, Problem 6.

INPUT DATA CODING FORM	UNIT	JOB DESCRIPTION	SYSTEM	PROGRAM	JOB NUMBER	DATE

FIELD DESCRIPTIONS

```
LINE
NO.   1   5    10   15   20   25   30   35   40   45   50   55   60   65   70   75   80
 1    6--SAMPLE PROBLEM--TSI ØPTIØN WITH 2 CØMPARISØNS
 2        PLAN 1--CØMPARE THINNING WITH NØ TREATMENT
 3        PLAN 2--CØMPARE THINNING AND PRUNING WITH NØ TREATMENT
 4    .010.0011.1500301
 5    0201102       100100           011                            010101        0101
 6    0110101
 7    SAWTIMBER--MBF
 8    100  300  90100  300  90
 9       10.00     01.005
10    0201102       080080           011020102                      010101        0201
11    000   -26.00000   -26.00
12                000   -30.00
13    0303013
14    SAWTIMBER--MBF
15    035   50  50035   50  35
16    055  100  80055  100  85
17    080  700 100080  700 175
18       101.00    01.005
19    98
20
21
22
23
24
25
```

R4-6600-12b (8/66)

Figure 13. — Computer input, Problem 7.

INPUT DATA CODING FORM | UNIT | JOB DESCRIPTION | SYSTEM | PROGRAM | JOB NUMBER | DATE

FIELD DESCRIPTIONS

LINE NO.	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
1	7A--COMPARISON OF TIMBER GROWING ALTERNATIVES--15						YEAR ROTATION	04
2	PLAN 1	--SEED TREE CUT LEAVING GROUPS			OF SEED TREES 1/4 A		CRE--1/10 MBF	
3	PLAN 2	--CLEAR CUT AND PLANT ABOUT HALF			THE AREA--NATURAL REGN ON HALF			
4	PLAN 3	--CLEAR CUT ASSUMING ALL THE AREA			CUT WILL REGENERATE NATURALLY			
5	PLAN 4	--CLEAR CUT AND SEED HALF THE			AREA--NATURAL REGEN ON HALF			
6	.101 10. 1011. 1	0001						
7	0A01 1021 3041	05 50 55	05 50 55	1 1 0 70 70 94	0304		1 1 9 1 9 1 9 1	01 01
8	001	--1 1 0. 0009 1	--11 9. 1 0 0 0 1	--1. 5 0 0 1 0 1	--19. 1 0 0			
9	001	--2 1 0. 0 1 0 0 2	--1. 5 0 0 1 1 4	--1. 5 1 0 0 0 1	--1. 5 1 9			
10	001	--1. 4 0 0 1 4	--1. 5 0 1 0 1 5	--25. 1 0 9 9 1 4	--1. 5 1 9			
11	002	--1. 5 0 1 0 1 5	--11 5. 1 0 9	1 0 1 5	--22. 1 0 0			
12	0110	--4. 0 0						
13	0114	--1. 5 0						
14	0115	--25. 0 0						
15	0303 0 1 1 0 1							
16	SAWTIMBER MBF							
17	0911 4	50 05 55	35 1 0	80 05 55	3 1 1 9	70 05 55	31 1 9	17 9
18	0110 1 16	9 0						
19	0555 2 8 1 0	7 0						
20	1 1 0. 1 0 0	.0 0 5						
21	98							
22								
23								
24								
25								
	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

R4-6600-12b (8/66)

INPUT DATA CODING FORM	UNIT	JOB DESCRIPTION	SYSTEM	PROGRAM	JOB NUMBER	DATE

FIELD DESCRIPTIONS

```
78 CØMPARISØN ØF TIMBER GRØWING ALTERNATIVES--85 YEAR RØTATIØN
.910.001.10001
0401020304   085085085085       010707040304                  0101010101      01
000   -10.00001   -19.0001      -.500000   -9.00
000   -20.00002     -.500114    -.500001    -.50
001     -.400114    -.500115  -25.000114    -.50
002     -.500115  -15.00            0115  -22.00
010    -4.00
014     -.50
015   -25.00
0404020202
SAWTIMBER MBF
001    4  50050  100 60050   90  50050    90  50
010   16  90085  700100085  680  95085  680   95
050   80  50
085  650  95
    10.00      .005
99
```

R4-6600-12b (8/66)

A Word About the Output

The computer output for the seven problems is shown in figures 14-20. Note that all the input is printed on the output. Control cards 6 and 7, and 11 when used, are labeled along with the information they contain. This is to facilitate the search for errors in input should any occur. Thus, when KX (control card 7) is greater than 0, product evaluations are to be made. If KX is 0 and product control cards are included in the problem, an error message results and the computer aborts the problem.

When KCXX (control card 7) is greater than 0, periodic costs and incomes are read. The number under each of the six KCX's indicates the number of periodic costs and incomes included in each of the six alternatives or plans that can be read simultaneously.

When JXX (control card 7) is greater than 0, annual costs and incomes are read. The number under each of the six JX's indicates the number of annual costs and incomes to be read in each of the six possible alternatives or plans.

When NZZ is greater than 0 (it will be either 0 or 1), at least one of the alternatives or plans is to be treated as a terminated series. A 0 or 1 under the JX's indicates how each of the six possible alternatives or plans is to be evaluated:

0 = perpetual series

1 = terminated series

The IST is used only with program options 2 and 3 to indicate which evaluation is to be made. It is coded 1 on the first card set, and 2 on the second.

When KX is greater than 0, MX (control card 7) must also be greater than 0. MX indicates the number of price assumptions to be read. If MX is 2, there must be two cards of card type 13.

General option output. – The internal rate of return and present discounted net worth are given for the range of interest rates specified on control card 6.

Stand replacement option. – The output for this option first gives present discounted net worth for the future timber growing opportunity for the range of interest rates specified. Internal rate of return can be read from this. For problem 4, it is between 5.6 and 5.7 percent. For problem 5, it is between 4.8 and 4.9 percent for alternative or plan 1 and between 7.4 and 7.5 percent for alternative or plan 2.

Second, the output gives present discounted net worth for the future timber growing plan and present stand conversion plan combined. In interpreting this information, the user must specify the minimum acceptable return. If a 3.5 percent return is acceptable, in the case of problem 4 the manager would be financially ahead (present discounted net worth is greater) to hold the stand for another 10 years because present worth is greater under this plan. In the case of problem 5, if 3.6 percent return was acceptable it would be financially advantageous to cut the poor stand on the better land.

TSI option. – The output for this option includes the present discounted net worth for the two TSI plans compared under each of the six possible alternatives or plan comparisons. In addition it gives the present discounted net worth due to the difference between the plans compared. In the case of thinning compared with no cultural work, the internal rate of return for the thinning investment is between 5.2 and 5.3 percent. In the case of a program of thinning and pruning, internal rate of return on investment is between 4.5 and 4.6 percent indicating that pruning only lessened the financial opportunity.

Problem 7. It is obvious from this analysis that there is no financial advantage in leaving seed trees (plan 1). The calculations suggest the manager should evaluate closely seed production on the area prior to cutting. For obvious reasons he could not wait to see what the seed crop was likely to be before planning for future timber growing. However, financing for timber growing could be planned on the basis of plan 4 or plan 2.

Figure 14. — Computer output, Problem 1.

```
                                        INVESTMENT ANALYSIS PROGRAM NO.6.  INT. STA.

PROBLEM NO.    1--SAMPLE PROBLEM -PERIODIC COSTS AND INCOMES--


        PLAN 1--113 YEAR ROTATION
        PLAN 2--100 YEAR ROTATION

                                                    GENERAL EVALUATION OF ALTERNATIVES

                    RINT  RINT  RINT JPR
CONTROL CARD 6      .020  .001  .040   1

                   LX  LI  LI  LI  LI  LI  LI   LY   LY   LY   LY   LY   LY  KX KCXX KCX KCX
CONTROL CARD 7      2   1   2   0   0   0   0  113  100    0    0    0    0   0    5   5   5

                  JXX  JX  JX  JX  JX  JX  JX NZZ  NZ  NZ  NZ  NZ  NZ  NZ IST  MX
CONTROL CARD 7      0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

                                                    ROTATION LENGTH IN YEARS

          1                   2
        113                 100

PERIODIC COSTS AND INCOMES
 YEAR      COST       YEAR      COST       YEAR       COST       YEAR       COST       YEAR
    0     -3.00          0    -11.00
    1    -15.00          1    -25.00
   18    -35.00         16    -20.00
   60     97.20         60    145.80
  113    456.00        100    414.00



PROBLEM NO. 1--SAMPLE PROBLEM -PERIODIC COSTS AND INCOMES--

INTERNAL RATE OF RETURN FOR SCHEDULE 0001 IS BETWEEN   2.7 AND   2.8
WITH PRESENT WORTHS OF   2.99 AND  -0.23 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0002 IS BETWEEN   2.9 AND   3.0
WITH PRESENT WORTHS OF   2.14 AND  -1.53 RESPECTIVELY.

  PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST
                ALT-PLAN  1        ALT-PLAN  2        ALT-PLAN  0        ALT-PLAN  0
  RATE      (ROTATION 113)     (ROTATION 100)     (ROTATION   0)     (ROTATION   0)

   2.0             40.38              59.75
   2.1             32.86              50.16
   2.2             26.25              41.63
   2.3             20.41              34.02
   2.4             15.25              27.22
   2.5             10.67              21.11
   2.6              6.61              15.61
   2.7              2.99              10.66
   2.8             -0.23               6.19
   2.9             -3.10               2.14
   3.0             -5.67              -1.53
   3.1             -7.96              -4.85
   3.2            -10.01              -7.87
   3.3            -11.85             -10.62
   3.4            -13.49             -13.12
   3.5            -14.96             -15.40
   3.6            -16.27             -17.48
   3.7            -17.45             -19.38
   3.8            -18.50             -21.11
   3.9            -19.44             -22.69
   4.0            -20.28             -24.14
```

Figure 15. — Computer output, Problem 2.

```
PROBLEM NO.   2--SAMPLE PROBLEM--PERIODIC AND ANNUAL COSTS AND INCOMES                    ID=  2


        PLAN 1--PERPETUATED SERIES
        PLAN 2--TERMINATED SERIES

                                                GENERAL EVALUATION OF ALTERNATIVES

                     RINT  RINT  RINT JPR
CONTROL CARD 6       .005  .001  .100   1

                     LX  LI  LI  LI  LI  LI  LI  LY  LY  LY  LY  LY  LY  KX KCXX KCX KCX KCX KCX KCX KCX
CONTROL CARD 7        2   1   2   0   0   0   0  40  40   0   0   0   0   0    9   9   9   0   0   0   0

                     JXX  JX  JX  JX  JX  JX  JX NZZ  NZ  NZ  NZ  NZ  NZ  NZ IST  MX
CONTROL CARD 7        1   1   1   0   0   0   0   1   0   1   0   0   0   0   0   0

                                                ROTATION LENGTH IN YEARS

          1                   2
         40                  40

PERIODIC COSTS AND INCOMES
 YEAR      COST      YEAR      COST      YEAR      COST      YEAR      COST      YEAR      COST      YEAR      COST
    0    -25.00         0    -25.00
    0    -20.00         0    -20.00
    4     -6.00         4     -6.00
    8     -3.00         8     -3.00
   15     20.00        15     20.00
   25     36.00        25     36.00
   33     40.00        33     40.00
   40    450.00        40    450.00
   40     25.00        40     25.00

ANNUAL COSTS AND RETURNS--ALT. OR PLAN   1
          1ST YEAR   0  END YEAR  40  $    -1.12  CHANGE       0

ANNUAL COSTS AND RETURNS--ALT. OR PLAN   2
          1ST YEAR   0  END YEAR  40  $    -1.12  CHANGE       0
```

PROBLEM NO. 2--SAMPLE PROBLEM--PERIODIC AND ANNUAL COSTS AND INCOMES

INTERNAL RATE OF RETURN FOR SCHEDULE 0001 IS BETWEEN 6.0 AND 6.1
WITH PRESENT WORTHS OF .30 AND -1.86 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0002 IS BETWEEN 6.0 AND 6.1
WITH PRESENT WORTHS OF .27 AND -1.68 RESPECTIVELY.

PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST

RATE	ALT-PLAN 1 (ROTATION 40)	ALT-PLAN 2 (ROTATION 40)	ALT-PLAN 0 (ROTATION 0)
.5	2095.98	379.08	
.6	1703.84	362.59	
.7	1424.13	346.75	
.8	1214.69	331.52	
.9	1052.09	316.89	
1.0	922.28	302.83	
1.1	816.31	289.31	
1.2	728.23	276.32	
1.3	653.91	263.84	
1.4	590.39	251.84	
1.5	535.52	240.31	
1.6	487.67	229.22	
1.7	445.61	218.56	
1.8	408.37	208.32	
1.9	375.18	198.47	
2.0	345.44	188.99	
2.1	318.66	179.89	
2.2	294.42	171.13	
2.3	272.41	162.71	
2.4	252.33	154.61	
2.5	233.96	146.83	
2.6	217.10	139.34	
2.7	201.58	132.14	
2.8	187.26	125.21	
2.9	174.00	118.55	
3.0	161.71	112.14	
3.1	150.29	105.97	
3.2	139.66	100.04	
3.3	129.75	94.34	
3.4	120.48	88.85	
3.5	111.81	83.57	
3.6	103.69	78.49	
3.7	96.06	73.60	
3.8	88.90	68.90	
3.9	82.16	64.38	
4.0	75.81	60.02	
4.1	69.83	55.83	
4.2	64.18	51.80	
4.3	58.84	47.92	
4.4	53.79	44.18	
4.5	49.01	40.59	
4.6	44.49	37.13	
4.7	40.20	33.80	
4.8	36.13	30.59	
4.9	32.26	27.50	
5.0	28.59	24.53	
5.1	25.11	21.67	
5.2	21.79	18.92	
5.3	18.63	16.27	
5.4	15.62	13.72	
5.5	12.76	11.26	
5.6	10.03	8.89	
5.7	7.42	6.61	
5.8	4.94	4.42	
5.9	2.57	2.31	
6.0	.30	.27	
6.1	-1.86	-1.68	
6.2	-3.92	-3.57	
6.3	-5.90	-5.39	
6.4	-7.79	-7.14	
6.5	-9.60	-8.82	
6.6	-11.32	-10.45	
6.7	-12.98	-12.01	
6.8	-14.56	-13.52	
6.9	-16.08	-14.97	
7.0	-17.53	-16.36	
7.1	-18.93	-17.71	
7.2	-20.26	-19.01	
7.3	-21.54	-20.25	
7.4	-22.77	-21.46	
7.5	-23.94	-22.62	
7.6	-25.07	-23.73	
7.7	-26.15	-24.81	
7.8	-27.19	-25.84	
7.9	-28.19	-26.84	
8.0	-29.15	-27.80	
8.1	-30.07	-28.73	
8.2	-30.95	-29.62	
8.3	-31.79	-30.48	
8.4	-32.61	-31.31	
8.5	-33.39	-32.11	
8.6	-34.14	-32.88	
8.7	-34.86	-33.62	
8.8	-35.56	-34.34	
8.9	-36.22	-35.02	
9.0	-36.86	-35.69	
9.1	-37.48	-36.33	
9.2	-38.07	-36.94	
9.3	-38.64	-37.54	
9.4	-39.18	-38.11	
9.5	-39.71	-38.66	
9.6	-40.22	-39.19	
9.7	-40.70	-39.70	
9.8	-41.17	-40.19	
9.9	-41.62	-40.67	
10.0	-42.05	-41.12	

Figure 16. — Computer output, Problem 3.

```
PROBLEM NO.    3--SAMPLE PROBLEM--PERIODIC COSTS AND INCOMES AND YIELD CALCULATIONS          ID=  1


    SAME AS PROBLEM 1 BUT WITH PRODUCT YIELDS COMPUTED BY THE MACHINE

                                                GENERAL EVALUATION OF ALTERNATIVES

                      RINT  RINT  RINT JPR
CONTROL CARD 6        .020  .001  .040   1

                      LX  LI  LI  LI  LI  LI  LI   LY   LY   LY   LY   LY   LY  KX KCXX KCX KCX KCX KCX KCX KCX
CONTROL CARD 7         2   1   2   0   0   0   0  113  100    0    0    0    0   1    3   3   3   0   0   0   0

                     JXX  JX  JX  JX  JX  JX  JX NZZ  NZ  NZ  NZ  NZ  NZ  NZ IST  MX
CONTROL CARD 7         0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1

                                                                ROTATION LENGTH IN YEARS

          1                   2
        113                 100

PERIODIC COSTS AND INCOMES
 YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST
    0     -3.00          0    -11.00
    1    -15.00          1    -25.00
   18    -35.00         16    -20.00

                     K1XX  K1X  K1X  K1X  K1X  K1X  K1X
CONTROL CARD 11         6    6    4    0    0    0    0
                     K2XX  K2X  K2X  K2X  K2X  K2X  K2X
CONTROL CARD 11         0    0    0    0    0    0    0
                     K3XX  K3X  K3X  K3X  K3X  K3X  K3X
CONTROL CARD 11         0    0    0    0    0    0    0

PERIODIC RETURNS FROM SAWTIMBER--CU FT
  YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL
    60  9720   60        60 12150   50
    60  3240   50        60 12150   70
    60  3240   70       100 38000   50
   113 51600   60       100 32000   70
   113 12200   50         0     0    0
   113 12200   70         0     0    0

 PRODUCT PRICES
             PRODUCT NO.1              PRODUCT NO.2              PRODUCT NO.3

        $      .100  CH       0
```

PROBLEM NO. 3--SAMPLE PROBLEM--PERIODIC COSTS AND INCOMES AND YIELD CALCULATIONS

INTERNAL RATE OF RETURN FOR SCHEDULE 0001 IS BETWEEN 2.7 AND 2.8
WITH PRESENT WORTHS OF 2.99 AND -0.23 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0002 IS BETWEEN 2.9 AND 3.0
WITH PRESENT WORTHS OF 2.14 AND -1.53 RESPECTIVELY.

PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST

RATE	ALT-PLAN 1 (ROTATION 113)	ALT-PLAN 2 (ROTATION 100)	ALT-PLAN 0 (ROTATION 0)	ALT-PLAN 0 (ROTATION 0)	ALT-PLAN 0 (ROTATION 0)	ALT-PLAN 0 (ROTATION 0)
2.0	40.38	59.75				
2.1	32.86	50.16				
2.2	26.25	41.63				
2.3	20.41	34.02				
2.4	15.25	27.22				
2.5	10.67	21.11				
2.6	6.61	15.61				
2.7	2.99	10.66				
2.8	-0.23	6.19				
2.9	-3.10	2.14				
3.0	-5.67	-1.53				
3.1	-7.96	-4.85				
3.2	-10.01	-7.87				
3.3	-11.85	-10.62				
3.4	-13.49	-13.12				
3.5	-14.96	-15.40				
3.6	-16.27	-17.48				
3.7	-17.45	-19.38				
3.8	-18.50	-21.11				
3.9	-19.44	-22.69				
4.0	-20.28	-24.14				

Figure 17. — Computer output, Problem 4.

```
PROBLEM NO.    4--SAMPLE PROBLEM--STAND REPLACEMENT--CUT NOW OR IN 10 YEARS                    ID=  3


        PLAN 1--CUT NOW
        PLAN 2--CUT IN 10 YEARS
             SAME FUTURE TIMBER GROWING PROGRAM IN BOTH PLANS

                                          EVALUATION OF STAND REPLACEMENT PRIORITIES

                    RINT  RINT  RINT JPR
CONTROL CARD 6      .010  .001  .070   2

CONTROL CARDS FOR FUTURE STANDS*****

                   LX  LI  LI  LI  LI  LI  LI   LY   LY   LY   LY   LY   LY  KX KCXX KCX KCX KCX KCX KCX KCX
CONTROL CARD 7      2   1   2   0   0   0   0   81   81    0    0    0    0   1    2   2   2   0   0   0   0

                  JXX  JX  JX  JX  JX  JX  JX NZZ  NZ  NZ  NZ  NZ  NZ  NZ IST  MX
CONTROL CARD 7      0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   1

                                                    ROTATION LENGTH IN YEARS
          1                    2
         81                   81

PERIODIC COSTS AND INCOMES
 YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST
    1     -5.00          1     -5.00
   21    -22.00         21    -22.00

                  K1XX  K1X  K1X  K1X  K1X  K1X  K1X
CONTROL CARD 11      2    2    2    0    0    0    0
                  K2XX  K2X  K2X  K2X  K2X  K2X  K2X
CONTROL CARD 11      0    0    0    0    0    0    0
                  K3XX  K3X  K3X  K3X  K3X  K3X  K3X
CONTROL CARD 11      0    0    0    0    0    0    0

PERIODIC RETURNS FROM SAWTIMBER--100 CU FT
  YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL
    51   250   35        51   250   35
    81   900  110        81   900  110

 PRODUCT PRICES
             PRODUCT NO.1              PRODUCT NO.2              PRODUCT NO.3

        $    5.000  CH   .005
```

PROBLEM NO. 4--SAMPLE PROBLEM--STAND REPLACEMENT--CUT NOW OR IN 10 YEARS

DISCOUNTED NET WORTH OF FUTURE CROPS

RATE	ALT-PLAN 1 (ROTATION 81)	ALT-PLAN 2 (ROTATION 81)	ALT-PLAN 0 (ROTATION 0)
1.0	579.90	579.90	
1.1	503.11	503.11	
1.2	439.82	439.82	
1.3	386.91	386.91	
1.4	342.14	342.14	
1.5	303.88	303.88	
1.6	270.90	270.90	
1.7	242.26	242.26	
1.8	217.23	217.23	
1.9	195.22	195.22	
2.0	175.78	175.78	
2.1	158.53	158.53	
2.2	143.17	143.17	
2.3	129.45	129.45	
2.4	117.14	117.14	
2.5	106.08	106.08	
2.6	96.11	96.11	
2.7	87.10	87.10	
2.8	78.95	78.95	
2.9	71.56	71.56	
3.0	64.85	64.85	
3.1	58.75	58.75	
3.2	53.19	53.19	
3.3	48.12	48.12	
3.4	43.50	43.50	
3.5	39.27	39.27	
3.6	35.41	35.41	
3.7	31.87	31.87	
3.8	28.63	28.63	
3.9	25.66	25.66	
4.0	22.94	22.94	
4.1	20.44	20.44	
4.2	18.14	18.14	
4.3	16.04	16.04	
4.4	14.10	14.10	
4.5	12.32	12.32	
4.6	10.69	10.69	
4.7	9.19	9.19	
4.8	7.81	7.81	
4.9	6.54	6.54	
5.0	5.37	5.37	
5.1	4.30	4.30	
5.2	3.31	3.31	
5.3	2.40	2.40	
5.4	1.57	1.57	
5.5	.80	.80	
5.6	.09	.09	
5.7	-0.55	-0.55	
5.8	-1.15	-1.15	
5.9	-1.69	-1.69	
6.0	-2.19	-2.19	
6.1	-2.65	-2.65	
6.2	-3.07	-3.07	
6.3	-3.46	-3.46	
6.4	-3.81	-3.81	
6.5	-4.13	-4.13	
6.6	-4.43	-4.43	
6.7	-4.70	-4.70	
6.8	-4.94	-4.94	
6.9	-5.17	-5.17	
7.0	-5.37	-5.37	

CONTROL CARDS 7* FOR PRESENT STAND*****

	LX	LI	LI	LI	LI	LI	LI	LY	LY	LY	LY	LY	LY	KX	KCXX	KCX	KCX	KCX	KCX	KCX	KCX
CONTROL CARD 7	2	1	2	0	0	0	0	0	10	0	0	0	0	1	0	0	0	0	0	0	0

	JXX	JX	JX	JX	JX	JX	JX	NZZ	NZ	NZ	NZ	NZ	NZ	NZ	IST	MX
CONTROL CARD 7	0	0	0	0	0	0	0	1	1	1	0	0	0	0	2	1

ROTATION LENGTH IN YEARS

1		2
0		10

	K1XX	K1X	K1X	K1X	K1X	K1X	K1X
CONTROL CARD 11	1	1	1	0	0	0	0
	K2XX	K2X	K2X	K2X	K2X	K2X	K2X
CONTROL CARD 11	0	0	0	0	0	0	0
	K3XX	K3X	K3X	K3X	K3X	K3X	K3X
CONTROL CARD 11	0	0	0	0	0	0	0

PERIODIC RETURNS FROM SAWTIMBER--100 CU FT

YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL
0	700	90	10	800	110												

PRODUCT PRICES

	PRODUCT NO.1			PRODUCT NO.2		PRODUCT NO.3	
$	5.000	CH	.005				

PROBLEM NO. 4--SAMPLE PROBLEM--STAND REPLACEMENT--CUT NOW OR IN 10 YEARS

DISCOUNTED NET WORTH OF PRESENT AND FUTURE CROPS

RATE	ALT-PLAN 1 (ROTATION 0)	ALT-PLAN 2 (ROTATION 10)
1.0	894.90	943.22
1.1	818.11	865.10
1.2	754.82	800.41
1.3	701.91	746.05
1.4	657.14	699.77
1.5	618.88	659.94
1.6	585.90	625.33
1.7	557.26	595.01
1.8	532.23	568.25
1.9	510.22	544.46
2.0	490.78	523.20
2.1	473.53	504.09
2.2	458.17	486.82
2.3	444.45	471.15
2.4	432.14	456.86
2.5	421.08	443.78
2.6	411.11	431.76
2.7	402.10	420.68
2.8	393.95	410.42
2.9	386.56	400.90
3.0	379.85	392.03
3.1	373.75	383.74
3.2	368.19	375.99
3.3	363.12	368.70
3.4	358.50	361.84
3.5	354.27	355.36
3.6	350.41	349.23
3.7	346.87	343.42
3.8	343.63	337.89
3.9	340.66	332.63
4.0	337.94	327.61
4.1	335.44	322.80
4.2	333.14	318.20
4.3	331.04	313.78
4.4	329.10	309.52
4.5	327.32	305.43
4.6	325.69	301.48
4.7	324.19	297.66
4.8	322.81	293.97
4.9	321.54	290.39
5.0	320.37	286.92
5.1	319.30	283.55
5.2	318.31	280.27
5.3	317.40	277.08
5.4	316.57	273.97
5.5	315.80	270.94
5.6	315.09	267.97
5.7	314.45	265.08
5.8	313.85	262.24
5.9	313.31	259.47
6.0	312.81	256.75
6.1	312.35	254.09
6.2	311.93	251.48
6.3	311.54	248.91
6.4	311.19	246.39
6.5	310.87	243.92
6.6	310.57	241.48
6.7	310.30	239.09
6.8	310.06	236.73
6.9	309.83	234.41
7.0	309.63	232.13

Figure 18. — Computer output, Problem 5.

```
PROBLEM NO.    5--SAMPLE PROBLEM--STAND REPLACEMENT -COMPARISON OF 2 STANDS                    ID=  2


        PLAN 1--CUT HIGHEST VOLUME STAND ON POOR LAND
        PLAN 2--CUT LOW VOLUME STAND ON GOOD LAND

                                          EVALUATION OF STAND REPLACEMENT PRIORITIES

                    RINT  RINT  RINT JPR
CONTROL CARD 6      .010  .001  .100   2

CONTROL CARDS FOR FUTURE STANDS*****

                   LX  LI  LI  LI  LI  LI  LI   LY   LY   LY   LY   LY   LY  KX KCXX KCX KCX KCX KCX KCX KCX
CONTROL CARD 7      2   3   7   0   0   0   0  110   81    0    0    0    0   1    1   1   1   0   0   0   0

                  JXX  JX  JX  JX  JX  JX  JX NZZ  NZ  NZ  NZ  NZ  NZ  NZ IST  MX
CONTROL CARD 7      0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   1

                                                    ROTATION LENGTH IN YEARS

          3                   7
        110                  81

PERIODIC COSTS AND INCOMES
 YEAR      COST      YEAR      COST      YEAR      COST      YEAR      COST      YEAR      COST      YEAR      COST
   30    -25.00        15    -25.00

                  K1XX  K1X  K1X  K1X  K1X  K1X  K1X
CONTROL CARD 11      2    2    2    0    0    0    0
                  K2XX  K2X  K2X  K2X  K2X  K2X  K2X
CONTROL CARD 11      0    0    0    0    0    0    0
                  K3XX  K3X  K3X  K3X  K3X  K3X  K3X
CONTROL CARD 11      0    0    0    0    0    0    0

PERIODIC RETURNS FROM SAWTIMBER--100 CU FT
  YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL
    75   200   35        50   300   50
   110   800   90        81  1200  140

 PRODUCT PRICES
             PRODUCT NO.1              PRODUCT NO.2              PRODUCT NO.3

        $    7.000  CH   .005
```

PROBLEM NO. 5--SAMPLE PROBLEM--STAND REPLACEMENT -COMPARISON OF 2 STANDS

DISCOUNTED NET WORTH OF FUTURE CROPS

RATE	ALT-PLAN 3 (ROTATION 110)	ALT-PLAN 7 (ROTATION 81)
1.0	413.13	1438.99
1.1	351.73	1252.02
1.2	301.59	1097.88
1.3	260.11	968.96
1.4	225.39	859.84
1.5	196.06	766.54
1.6	171.09	686.07
1.7	149.70	616.15
1.8	131.26	555.00
1.9	115.29	501.21
2.0	101.40	453.67
2.1	89.27	411.45
2.2	78.65	373.82
2.3	69.33	340.16
2.4	61.12	309.96
2.5	53.88	282.78
2.6	47.48	258.26
2.7	41.81	236.09
2.8	36.79	216.00
2.9	32.34	197.76
3.0	28.39	181.18
3.1	24.87	166.07
3.2	21.74	152.29
3.3	18.96	139.71
3.4	16.48	128.20
3.5	14.28	117.67
3.6	12.31	108.02
3.7	10.56	99.17
3.8	9.01	91.04
3.9	7.62	83.58
4.0	6.38	76.71
4.1	5.28	70.40
4.2	4.31	64.59
4.3	3.44	59.24
4.4	2.67	54.30
4.5	1.99	49.76
4.6	1.38	45.56
4.7	.85	41.69
4.8	.38	38.12
4.9	-0.04	34.83
5.0	-0.40	31.78
5.1	-0.72	28.97
5.2	-1.00	26.37
5.3	-1.25	23.97
5.4	-1.46	21.75
5.5	-1.64	19.69
5.6	-1.80	17.80
5.7	-1.93	16.04
5.8	-2.05	14.42
5.9	-2.14	12.92
6.0	-2.22	11.53
6.1	-2.28	10.25
6.2	-2.33	9.06
6.3	-2.37	7.96
6.4	-2.40	6.95
6.5	-2.42	6.01
6.6	-2.43	5.14
6.7	-2.43	4.34
6.8	-2.43	3.60
6.9	-2.42	2.92
7.0	-2.41	2.29
7.1	-2.39	1.71
7.2	-2.37	1.17
7.3	-2.34	.68
7.4	-2.32	.22
7.5	-2.29	-0.20
7.6	-2.25	-0.59
7.7	-2.22	-0.94
7.8	-2.18	-1.27
7.9	-2.15	-1.57
8.0	-2.11	-1.84
8.1	-2.07	-2.10
8.2	-2.03	-2.33
8.3	-1.99	-2.54
8.4	-1.96	-2.73
8.5	-1.92	-2.91
8.6	-1.88	-3.07
8.7	-1.84	-3.21
8.8	-1.80	-3.34
8.9	-1.76	-3.46
9.0	-1.72	-3.57
9.1	-1.68	-3.66
9.2	-1.64	-3.75
9.3	-1.61	-3.82
9.4	-1.57	-3.89
9.5	-1.53	-3.95
9.6	-1.50	-4.00
9.7	-1.46	-4.04
9.8	-1.43	-4.08
9.9	-1.39	-4.11
10.0	-1.36	-4.14

CONTROL CARDS 7* FOR PRESENT STAND*****

	LX	LI	LI	LI	LI	LI	LI	LY	LY	LY	LY	LY	LY	KX	KCXX	KCX	KCX	KCX	KCX	KCX	KCX
CONTROL CARD 7	2	3	7	0	0	0	0	3	3	0	0	0	0	1	2	2	2	0	0	0	0

	JXX	JX	JX	JX	JX	JX	JX	NZZ	NZ	NZ	NZ	NZ	NZ	NZ	IST	MX
CONTROL CARD 7	0	0	0	0	0	0	0	1	1	1	0	0	0	0	2	1

ROTATION LENGTH IN YEARS

3		7	
3		3	

PERIODIC COSTS AND INCOMES

YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST
1	-7.00	1	-6.00								
2	-24.00	2	-22.00								

	K1XX	K1X	K1X	K1X	K1X	K1X	K1X
CONTROL CARD 11	1	1	1	0	0	0	0

	K2XX	K2X	K2X	K2X	K2X	K2X	K2X
CONTROL CARD 11	0	0	0	0	0	0	0

	K3XX	K3X	K3X	K3X	K3X	K3X	K3X
CONTROL CARD 11	0	0	0	0	0	0	0

PERIODIC RETURNS FROM SAWTIMBER--100 CU FT

YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL
3	740	90	3	590	90												

PRODUCT PRICES

	PRODUCT NO.1	PRODUCT NO.2	PRODUCT NO.3
$	7.000 CH .005		

PROBLEM NO. 5--SAMPLE PROBLEM--STAND REPLACEMENT -COMPARISON OF 2 STANDS

DISCOUNTED NET WORTH OF PRESENT AND FUTURE CROPS

RATE	ALT-PLAN 3 (ROTATION 3)	ALT-PLAN 7 (ROTATION 3)
1.0	829.80	1735.34
1.1	767.88	1549.23
1.2	717.20	1395.89
1.3	675.13	1267.71
1.4	639.80	1159.26
1.5	609.82	1066.59
1.6	584.19	986.68
1.7	562.09	917.27
1.8	542.92	856.57
1.9	526.19	803.18
2.0	511.52	755.99
2.1	498.59	714.07
2.2	487.14	676.70
2.3	476.97	643.24
2.4	467.89	613.20
2.5	459.76	586.13
2.6	452.46	561.69
2.7	445.88	539.55
2.8	439.92	519.45
2.9	434.52	501.17
3.0	429.60	484.50
3.1	425.11	469.28
3.2	420.99	455.35
3.3	417.21	442.58
3.4	413.73	430.86
3.5	410.50	420.08
3.6	407.51	410.15
3.7	404.73	401.00
3.8	402.14	392.54
3.9	399.71	384.73
4.0	397.42	377.48
4.1	395.27	370.77
4.2	393.24	364.54
4.3	391.31	358.74
4.4	389.47	353.35
4.5	387.72	348.32
4.6	386.05	343.63
4.7	384.45	339.24
4.8	382.90	335.14
4.9	381.42	331.30
5.0	379.98	327.69
5.1	378.58	324.30
5.2	377.23	321.12
5.3	375.92	318.12
5.4	374.63	315.28
5.5	373.38	312.61
5.6	372.15	310.08
5.7	370.95	307.69
5.8	369.77	305.42
5.9	368.62	303.26
6.0	367.48	301.21
6.1	366.35	299.25
6.2	365.24	297.39
6.3	364.15	295.61
6.4	363.07	293.91
6.5	362.00	292.27
6.6	360.94	290.71
6.7	359.89	289.20
6.8	358.85	287.76
6.9	357.82	286.36
7.0	356.80	285.02
7.1	355.78	283.72
7.2	354.77	282.46
7.3	353.77	281.24
7.4	352.77	280.06
7.5	351.78	278.91
7.6	350.80	277.80
7.7	349.82	276.71
7.8	348.84	275.65
7.9	347.87	274.62
8.0	346.90	273.61
8.1	345.94	272.63
8.2	344.98	271.66
8.3	344.03	270.72
8.4	343.08	269.79
8.5	342.13	268.88
8.6	341.18	267.98
8.7	340.24	267.11
8.8	339.31	266.24
8.9	338.37	265.39
9.0	337.44	264.55
9.1	336.51	263.72
9.2	335.59	262.91
9.3	334.67	262.10
9.4	333.75	261.31
9.5	332.83	260.52
9.6	331.92	259.74
9.7	331.01	258.97
9.8	330.10	258.21
9.9	329.20	257.46
10.0	328.30	256.71

Figure 19. — Computer output, Problem 6.

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PROBLEM NO.    6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS                                    ID=  2


        PLAN 1--COMPARE THINNING WITH NO TREATMENT
        PLAN 2--COMPARE THINNING AND PRUNING WITH NO TREATMENT

                                    EVALUATION OF TIMBER STAND IMPROVEMENT PROGRAMS

                    RINT  RINT  RINT JPR
CONTROL CARD 6      .010  .001  .150   3

CONTROL CARDS FOR FIRST TSI PLAN*****

                   LX  LI  LI  LI  LI  LI  LI   LY   LY   LY   LY   LY   LY  KX KCXX KCX KCX KCX KCX KCX KCX
CONTROL CARD 7      2   1   2   0   0   0   0  100  100    0    0    0    0   1    0   0   0   0   0   0   0

                  JXX  JX  JX  JX  JX  JX  JX NZZ  NZ  NZ  NZ  NZ  NZ  NZ IST  MX
CONTROL CARD 7      0   0   0   0   0   0   0   1   1   1   0   0   0   0   1   1

                                                    ROTATION LENGTH IN YEARS
          1                   2
        100                 100

                   K1XX  K1X  K1X  K1X  K1X  K1X  K1X
CONTROL CARD 11       1    1    1    0    0    0    0
                   K2XX  K2X  K2X  K2X  K2X  K2X  K2X
CONTROL CARD 11       0    0    0    0    0    0    0
                   K3XX  K3X  K3X  K3X  K3X  K3X  K3X
CONTROL CARD 11       0    0    0    0    0    0    0

PERIODIC RETURNS FROM SAWTIMBER--MBF
  YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL
   100   300   90       100   300   90

 PRODUCT PRICES
             PRODUCT NO.1              PRODUCT NO.2              PRODUCT NO.3

        $   10.000  CH   .005
```

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH--FIRST TSI PLAN

RATE	ALT-PLAN 1 (ROTATION 100)	ALT-PLAN 2 (ROTATION 100)
1.0	149.73	149.73
1.1	135.62	135.62
1.2	122.86	122.86
1.3	111.30	111.30
1.4	100.85	100.85
1.5	91.38	91.38
1.6	82.81	82.81
1.7	75.05	75.05
1.8	68.03	68.03
1.9	61.66	61.66
2.0	55.90	55.90
2.1	50.69	50.69
2.2	45.96	45.96
2.3	41.68	41.68
2.4	37.80	37.80
2.5	34.28	34.28
2.6	31.10	31.10
2.7	28.21	28.21
2.8	25.59	25.59
2.9	23.22	23.22
3.0	21.07	21.07
3.1	19.12	19.12
3.2	17.36	17.36
3.3	15.76	15.76
3.4	14.30	14.30
3.5	12.98	12.98
3.6	11.79	11.79
3.7	10.70	10.70
3.8	9.72	9.72
3.9	8.83	8.83
4.0	8.02	8.02
4.1	7.28	7.28
4.2	6.62	6.62
4.3	6.01	6.01
4.4	5.46	5.46
4.5	4.96	4.96
4.6	4.51	4.51
4.7	4.10	4.10
4.8	3.73	3.73
4.9	3.39	3.39
5.0	3.08	3.08
5.1	2.80	2.80
5.2	2.55	2.55
5.3	2.32	2.32
5.4	2.11	2.11
5.5	1.92	1.92
5.6	1.74	1.74
5.7	1.58	1.58
5.8	1.44	1.44
5.9	1.31	1.31
6.0	1.19	1.19
6.1	1.09	1.09
6.2	.99	.99
6.3	.90	.90
6.4	.82	.82
6.5	.75	.75
6.6	.68	.68
6.7	.62	.62
6.8	.56	.56
6.9	.51	.51
7.0	.47	.47
7.1	.43	.43
7.2	.39	.39
7.3	.35	.35
7.4	.32	.32
7.5	.29	.29
7.6	.27	.27
7.7	.24	.24
7.8	.22	.22
7.9	.20	.20
8.0	.18	.18
8.1	.17	.17
8.2	.15	.15
8.3	.14	.14
8.4	.13	.13
8.5	.12	.12
8.6	.11	.11
8.7	.10	.10
8.8	.09	.09
8.9	.08	.08
9.0	.07	.07
9.1	.07	.07
9.2	.06	.06
9.3	.06	.06
9.4	.05	.05
9.5	.05	.05
9.6	.04	.04
9.7	.04	.04
9.8	.04	.04
9.9	.03	.03
10.0	.03	.03

CONTROL CARDS 7+ FOR SECOND TSI PLAN*****

	LX	LI	LI	LI	LI	LI	LI	LY	LY	LY	LY	LY	LY	KX	KCXX	KCX	KCX	KCX	KCX	KCX	KCX
CONTROL CARD 7	2	1	2	0	0	0	0	80	80	0	0	0	0	1	2	1	2	0	0	0	0

	JXX	JX	JX	JX	JX	JX	JX	NZZ	NZ	NZ	NZ	NZ	NZ	NZ	IST	MX
CONTROL CARD 7	0	0	0	0	0	0	0	1	1	1	0	0	0	0	2	1

ROTATION LENGTH IN YEARS

1	2
80	80

PERIODIC COSTS AND INCOMES

YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST
0	-26.00	0	-26.00								
0	0	0	-30.00								

	K1XX	K1X	K1X	K1X	K1X	K1X	K1X
CONTROL CARD 11	3	3	3	0	0	0	0
	K2XX	K2X	K2X	K2X	K2X	K2X	K2X
CONTROL CARD 11	0	0	0	0	0	0	0
	K3XX	K3X	K3X	K3X	K3X	K3X	K3X
CONTROL CARD 11	0	0	0	0	0	0	0

PERIODIC RETURNS FROM SAWTIMBER--MBF

YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL
35	50	50	35	50	35												
55	100	80	55	100	85												
80	700	110	80	700	175												

PRODUCT PRICES

PRODUCT NO.1	PRODUCT NO.2	PRODUCT NO.3
$ 10.000 CH .005		

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH--SECOND TSI PLAN

RATE	ALT-PLAN 1 (ROTATION 80)	ALT-PLAN 2 (ROTATION 80)
1.0	540.05	794.88
1.1	499.20	732.18
1.2	461.40	674.20
1.3	426.41	620.60
1.4	394.01	571.02
1.5	364.01	525.17
1.6	336.23	482.75
1.7	310.50	443.51
1.8	286.67	407.21
1.9	264.58	373.61
2.0	244.12	342.51
2.1	225.15	313.73
2.2	207.57	287.09
2.3	191.27	262.41
2.4	176.15	239.57
2.5	162.13	218.41
2.6	149.12	198.81
2.7	137.06	180.66
2.8	125.86	163.84
2.9	115.47	148.25
3.0	105.82	133.80
3.1	96.86	120.41
3.2	88.54	108.00
3.3	80.81	96.49
3.4	73.63	85.81
3.5	66.96	75.91
3.6	60.76	66.73
3.7	54.99	58.21
3.8	49.63	50.30
3.9	44.65	42.96
4.0	40.01	36.15
4.1	35.69	29.83
4.2	31.68	23.95
4.3	27.94	18.50
4.4	24.46	13.43
4.5	21.22	8.73
4.6	18.20	4.36
4.7	15.39	.29
4.8	12.77	-3.49
4.9	10.32	-7.00
5.0	8.05	-10.26
5.1	5.92	-13.30
5.2	3.94	-16.13
5.3	2.09	-18.76
5.4	.36	-21.20
5.5	-1.25	-23.48
5.6	-2.76	-25.60
5.7	-4.16	-27.57
5.8	-5.47	-29.41
5.9	-6.70	-31.12
6.0	-7.85	-32.72
6.1	-8.92	-34.20
6.2	-9.93	-35.59
6.3	-10.87	-36.88
6.4	-11.75	-38.09
6.5	-12.57	-39.21
6.6	-13.34	-40.26
6.7	-14.07	-41.24
6.8	-14.74	-42.15
6.9	-15.38	-43.01
7.0	-15.97	-43.80
7.1	-16.53	-44.55
7.2	-17.05	-45.24
7.3	-17.55	-45.89
7.4	-18.01	-46.50
7.5	-18.44	-47.07
7.6	-18.85	-47.60
7.7	-19.23	-48.09
7.8	-19.59	-48.56
7.9	-19.93	-49.00
8.0	-20.25	-49.40
8.1	-20.55	-49.78
8.2	-20.83	-50.14
8.3	-21.10	-50.48
8.4	-21.35	-50.79
8.5	-21.58	-51.09
8.6	-21.81	-51.36
8.7	-22.02	-51.62
8.8	-22.21	-51.86
8.9	-22.40	-52.09
9.0	-22.58	-52.31
9.1	-22.74	-52.51
9.2	-22.90	-52.70
9.3	-23.05	-52.88
9.4	-23.19	-53.04
9.5	-23.32	-53.20
9.6	-23.45	-53.35
9.7	-23.57	-53.49
9.8	-23.68	-53.62
9.9	-23.79	-53.74
10.0	-23.89	-53.86

PROBLEM NO. 6--SAMPLE PROBLEM--TSI OPTION WITH 2 COMPARISONS

DISCOUNTED NET WORTH OF ADDED TSI INVESTMENT

RATE	ALT-PLAN 1 (ROTATION 80)	ALT-PLAN 2 (ROTATION 80)
1.0	390.32	645.15
1.1	363.58	596.55
1.2	338.54	551.34
1.3	315.10	509.29
1.4	293.16	470.17
1.5	272.63	433.79
1.6	253.42	399.94
1.7	235.45	368.46
1.8	218.64	339.18
1.9	202.92	311.94
2.0	188.22	286.61
2.1	174.47	263.05
2.2	161.61	241.13
2.3	149.59	220.74
2.4	138.35	201.77
2.5	127.85	184.13
2.6	118.03	167.72
2.7	108.85	152.45
2.8	100.26	138.24
2.9	92.24	125.03
3.0	84.74	112.73
3.1	77.73	101.29
3.2	71.18	90.64
3.3	65.05	80.73
3.4	59.33	71.51
3.5	53.97	62.93
3.6	48.97	54.94
3.7	44.29	47.50
3.8	39.91	40.58
3.9	35.82	34.13
4.0	31.99	28.13
4.1	28.41	22.54
4.2	25.06	17.34
4.3	21.93	12.49
4.4	19.00	7.97
4.5	16.26	3.76
4.6	13.69	-0.16
4.7	11.29	-3.81
4.8	9.04	-7.21
4.9	6.94	-10.39
5.0	4.97	-13.34
5.1	3.12	-16.10
5.2	1.39	-18.67
5.3	-0.23	-21.07
5.4	-1.74	-23.31
5.5	-3.16	-25.39
5.6	-4.50	-27.34
5.7	-5.75	-29.16
5.8	-6.92	-30.85
5.9	-8.01	-32.43
6.0	-9.04	-33.91
6.1	-10.01	-35.29
6.2	-10.92	-36.58
6.3	-11.77	-37.78
6.4	-12.57	-38.91
6.5	-13.32	-39.96
6.6	-14.02	-40.94
6.7	-14.68	-41.86
6.8	-15.31	-42.72
6.9	-15.89	-43.52
7.0	-16.44	-44.27
7.1	-16.96	-44.97
7.2	-17.44	-45.63
7.3	-17.90	-46.24
7.4	-18.33	-46.82
7.5	-18.73	-47.36
7.6	-19.12	-47.86
7.7	-19.48	-48.34
7.8	-19.81	-48.78
7.9	-20.13	-49.20
8.0	-20.43	-49.59
8.1	-20.72	-49.95
8.2	-20.98	-50.30
8.3	-21.24	-50.62
8.4	-21.47	-50.92
8.5	-21.70	-51.20
8.6	-21.91	-51.47
8.7	-22.11	-51.72
8.8	-22.30	-51.95
8.9	-22.48	-52.17
9.0	-22.65	-52.38
9.1	-22.81	-52.58
9.2	-22.96	-52.76
9.3	-23.11	-52.93
9.4	-23.24	-53.09
9.5	-23.37	-53.25
9.6	-23.49	-53.39
9.7	-23.61	-53.53
9.8	-23.72	-53.65
9.9	-23.82	-53.77
10.0	-23.92	-53.89

Figure 20. — Computer output, Problem 7.

```
PROBLEM NO.    7A--COMPARISON OF TIMBER GROWING ALTERNATIVES--55 YEAR ROTATION                    ID=  4


        PLAN 1--SEED TREE CUT LEAVING GROUPS OF SEED TREES 1/4 ACRE--10 MBF
        PLAN 2--CLEAR CUT AND PLANT ABOUT HALF THE AREA--NATURAL REGEN ON HALF
        PLAN 3--CLEAR CUT  ASSUMING ALL THE AREAS CUT WILL REGENERATE NATURALLY
        PLAN 4--CLEAR CUT AND SEED HALF THE AREA--NATURAL REGEN ON HALF

                                          GENERAL EVALUATION OF ALTERNATIVES

                      RINT  RINT  RINT JPR
CONTROL CARD 6         .010  .001  .100   1

                     LX  LI  LI  LI  LI  LI  LI   LY   LY   LY   LY   LY   LY  KX KCXX KCX KCX KCX KCX KCX KCX
CONTROL CARD 7        4   1   2   3   4   0   0   55   55   55   55    0    0   1    7   7   4   3   4   0   0

                     JXX  JX  JX  JX  JX  JX  JX NZZ  NZ  NZ  NZ  NZ  NZ  NZ IST  MX
CONTROL CARD 7        0   0   0   0   0   0   0   1   1   1   1   1   0   0   0   1

                                                        ROTATION LENGTH IN YEARS
                1                   2                   3                   4
               55                  55                  55                  55

PERIODIC COSTS AND INCOMES
 YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST       YEAR      COST
    0    -10.00          1    -19.00          1     -0.50          0     -9.00
    0    -20.00          2     -0.50         14     -0.50          1     -0.50
    1     -0.40         14     -0.50         15    -25.00         14     -0.50
    2     -0.50         15    -15.00          0         0         15    -22.00
   10     -4.00          0         0          0         0          0         0
   14     -0.50          0         0          0         0          0         0
   15    -25.00          0         0          0         0          0         0

                     K1XX  K1X  K1X  K1X  K1X  K1X  K1X
CONTROL CARD 11       3    3    1    1    1    0    0
                     K2XX  K2X  K2X  K2X  K2X  K2X  K2X
CONTROL CARD 11       0    0    0    0    0    0    0
                     K3XX  K3X  K3X  K3X  K3X  K3X  K3X
CONTROL CARD 11       0    0    0    0    0    0    0

PERIODIC RETURNS FROM SAWTIMBER MBF
  YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL
     1     4   50         55   350   80         55   310   70         55   310   70
    10    16   90          0     0    0          0     0    0          0     0    0
    55   280   70          0     0    0          0     0    0          0     0    0

 PRODUCT PRICES
              PRODUCT NO.1              PRODUCT NO.2              PRODUCT NO.3

        $   10.000  CH   .005
```

PROBLEM NO. 7A--COMPARISON OF TIMBER GROWING ALTERNATIVES--55 YEAR ROTATION

INTERNAL RATE OF RETURN FOR SCHEDULE 0001 IS BETWEEN 3.5 AND 3.6
WITH PRESENT WORTHS OF 1.42 AND -0.39 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0002 IS BETWEEN 4.8 AND 4.9
WITH PRESENT WORTHS OF .82 AND -0.44 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0003 IS BETWEEN 6.0 AND 6.1
WITH PRESENT WORTHS OF .10 AND -0.32 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0004 IS BETWEEN 4.8 AND 4.9
WITH PRESENT WORTHS OF .37 AND -0.55 RESPECTIVELY.

PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST

RATE	ALT-PLAN 1 (ROTATION 55)	ALT-PLAN 2 (ROTATION 55)	ALT-PLAN 3 (ROTATION 55)	ALT-PLAN 4 (ROTATION 55)	ALT-PLAN 0 (ROTATION 0)	ALT-PLAN 0 (ROTATION 0)
1.0	103.78	173.88	137.60	131.18		
1.1	96.34	163.15	129.45	122.99		
1.2	89.31	153.01	121.74	115.25		
1.3	82.67	143.43	114.46	107.94		
1.4	76.40	134.37	107.59	101.03		
1.5	70.47	125.80	101.10	94.50		
1.6	64.86	117.71	94.97	88.33		
1.7	59.57	110.05	89.17	82.50		
1.8	54.56	102.81	83.70	77.00		
1.9	49.83	95.97	78.54	71.80		
2.0	45.36	89.50	73.66	66.89		
2.1	41.13	83.38	69.05	62.25		
2.2	37.14	77.60	64.70	57.86		
2.3	33.37	72.13	60.59	53.72		
2.4	29.80	66.97	56.71	49.81		
2.5	26.43	62.08	53.04	46.12		
2.6	23.24	57.46	49.58	42.63		
2.7	20.23	53.09	46.32	39.33		
2.8	17.39	48.96	43.24	36.22		
2.9	14.70	45.06	40.33	33.28		
3.0	12.16	41.37	37.58	30.50		
3.1	9.76	37.88	34.99	27.88		
3.2	7.49	34.58	32.54	25.41		
3.3	5.35	31.47	30.23	23.07		
3.4	3.33	28.52	28.05	20.87		
3.5	1.42	25.73	26.00	18.79		
3.6	-0.39	23.10	24.06	16.82		
3.7	-2.10	20.61	22.23	14.97		
3.8	-3.71	18.26	20.51	13.22		
3.9	-5.23	16.04	18.88	11.57		
4.0	-6.67	13.94	17.35	10.01		
4.1	-8.03	11.96	15.90	8.55		
4.2	-9.31	10.08	14.54	7.16		
4.3	-10.52	8.31	13.26	5.85		
4.4	-11.66	6.64	12.05	4.62		
4.5	-12.74	5.06	10.91	3.46		
4.6	-13.76	3.56	9.84	2.37		
4.7	-14.72	2.15	8.83	1.34		
4.8	-15.63	.82	7.88	.37		

PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST

RATE	ALT-PLAN 1 (ROTATION 55)	ALT-PLAN 2 (ROTATION 55)	ALT-PLAN 3 (ROTATION 55)	ALT-PLAN 4 (ROTATION 55)	ALT-PLAN 0 (ROTATION 0)	ALT-PLAN 0 (ROTATION 0)
4.9	-16.49	-0.44	6.99	-0.55		
5.0	-17.30	-1.62	6.15	-1.41		
5.1	-18.06	-2.74	5.36	-2.22		
5.2	-18.78	-3.80	4.62	-2.98		
5.3	-19.46	-4.80	3.92	-3.70		
5.4	-20.10	-5.74	3.26	-4.37		
5.5	-20.70	-6.63	2.65	-5.01		
5.6	-21.27	-7.47	2.07	-5.60		
5.7	-21.80	-8.26	1.53	-6.16		
5.8	-22.31	-9.00	1.02	-6.69		
5.9	-22.78	-9.71	.55	-7.18		
6.0	-23.23	-10.37	.10	-7.65		
6.1	-23.65	-10.99	-0.32	-8.08		
6.2	-24.05	-11.58	-0.71	-8.49		
6.3	-24.42	-12.13	-1.07	-8.87		
6.4	-24.78	-12.65	-1.41	-9.23		
6.5	-25.11	-13.14	-1.73	-9.57		
6.6	-25.42	-13.60	-2.03	-9.88		
6.7	-25.71	-14.03	-2.31	-10.17		
6.8	-25.99	-14.44	-2.56	-10.45		
6.9	-26.24	-14.82	-2.80	-10.70		
7.0	-26.49	-15.18	-3.03	-10.94		
7.1	-26.71	-15.52	-3.23	-11.16		
7.2	-26.93	-15.84	-3.42	-11.37		
7.3	-27.13	-16.13	-3.60	-11.56		
7.4	-27.31	-16.41	-3.76	-11.74		
7.5	-27.49	-16.67	-3.91	-11.90		
7.6	-27.65	-16.92	-4.05	-12.05		
7.7	-27.81	-17.14	-4.18	-12.19		
7.8	-27.95	-17.36	-4.30	-12.32		
7.9	-28.09	-17.55	-4.40	-12.44		
8.0	-28.21	-17.74	-4.50	-12.55		
8.1	-28.33	-17.91	-4.59	-12.65		
8.2	-28.44	-18.07	-4.67	-12.75		
8.3	-28.54	-18.22	-4.74	-12.83		
8.4	-28.63	-18.36	-4.80	-12.91		
8.5	-28.72	-18.49	-4.86	-12.98		
8.6	-28.80	-18.61	-4.91	-13.04		
8.7	-28.88	-18.72	-4.95	-13.10		
8.8	-28.95	-18.82	-4.99	-13.15		
8.9	-29.02	-18.91	-5.03	-13.19		
9.0	-29.08	-19.00	-5.05	-13.23		
9.1	-29.13	-19.08	-5.08	-13.26		
9.2	-29.18	-19.15	-5.09	-13.29		
9.3	-29.23	-19.21	-5.11	-13.32		
9.4	-29.27	-19.27	-5.12	-13.34		
9.5	-29.31	-19.33	-5.12	-13.36		
9.6	-29.35	-19.38	-5.13	-13.37		
9.7	-29.38	-19.42	-5.13	-13.38		
9.8	-29.41	-19.46	-5.12	-13.39		
9.9	-29.43	-19.49	-5.12	-13.39		
10.0	-29.46	-19.52	-5.11	-13.39		

PROBLEM NO. 78--COMPARISON OF TIMBER GROWING ALTERNATIVES--85 YEAR ROTATION ID= 0

GENERAL EVALUATION OF ALTERNATIVES

	RINT	RINT	RINT	JPR
CONTROL CARD 6	.010	.001	.100	1

	LX	LI	LI	LI	LI	LI	LI	LY	LY	LY	LY	LY	LY	KX	KCXX	KCX	KCX	KCX	KCX	KCX	KCX
CONTROL CARD 7	4	1	2	3	4	0	0	85	85	85	85	0	0	1	7	7	4	3	4	0	0

	JXX	JX	JX	JX	JX	JX	JX	NZZ	NZ	NZ	NZ	NZ	NZ	NZ	IST	MX
CONTROL CARD 7	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	1

ROTATION LENGTH IN YEARS

1	2	3	4
85	85	85	85

PERIODIC COSTS AND INCOMES

YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST	YEAR	COST
0	-10.00	1	-19.00	1	-0.50	0	-9.00				
0	-20.00	2	-0.50	14	-0.50	1	-0.50				
1	-0.40	14	-0.50	15	-25.00	14	-0.50				
2	-0.50	15	-15.00	0	0	15	-22.00				
10	-4.00	0	0	0	0	0	0				
14	-0.50	0	0	0	0	0	0				
15	-25.00	0	0	0	0	0	0				

	K1XX	K1X	K1X	K1X	K1X	K1X	K1X
CONTROL CARD 11	4	4	2	2	2	0	0
	K2XX	K2X	K2X	K2X	K2X	K2X	K2X
CONTROL CARD 11	0	0	0	0	0	0	0
	K3XX	K3X	K3X	K3X	K3X	K3X	K3X
CONTROL CARD 11	0	0	0	0	0	0	0

PERIODIC RETURNS FROM SAWTIMBER MBF

YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL	YEAR	YIELD	QUAL
1	4	50	50	100	60	50	90	50	50	90	50						
10	16	90	85	700	100	85	680	95	85	680	95						
50	80	50	0	0	0	0	0	0	0	0	0						
85	650	95	0	0	0	0	0	0	0	0	0						

PRODUCT PRICES

PRODUCT NO.1	PRODUCT NO.2	PRODUCT NO.3
$ 10.000 CH .005		

PROBLEM NO. 7B--COMPARISON OF TIMBER GROWING ALTERNATIVES--85 YEAR ROTATION

INTERNAL RATE OF RETURN FOR SCHEDULE 0001 IS BETWEEN 4.1 AND 4.2
WITH PRESENT WORTHS OF .18 AND -2.27 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0002 IS BETWEEN 4.7 AND 4.8
WITH PRESENT WORTHS OF 1.26 AND -0.53 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0003 IS BETWEEN 5.7 AND 5.8
WITH PRESENT WORTHS OF .20 AND -0.44 RESPECTIVELY.

INTERNAL RATE OF RETURN FOR SCHEDULE 0004 IS BETWEEN 4.9 AND 5.0
WITH PRESENT WORTHS OF .46 AND -0.85 RESPECTIVELY.

PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST

RATE	ALT-PLAN 1 (ROTATION 85)	ALT-PLAN 2 (ROTATION 85)	ALT-PLAN 3 (ROTATION 85)	ALT-PLAN 4 (ROTATION 85)	ALT-PLAN 0 (ROTATION 0)	ALT-PLAN 0 (ROTATION 0)
1.0	367.29	441.10	406.86	400.44		
1.1	335.58	404.57	373.66	367.20		
1.2	306.42	370.96	343.13	336.64		
1.3	279.60	340.04	315.06	308.53		
1.4	254.94	311.59	289.24	282.68		
1.5	232.25	285.40	265.50	258.90		
1.6	211.38	261.30	243.67	237.03		
1.7	192.19	239.11	223.58	216.91		
1.8	174.52	218.68	205.11	198.40		
1.9	158.27	199.87	188.11	181.37		
2.0	143.31	182.54	172.47	165.70		
2.1	129.55	166.59	158.08	151.28		
2.2	116.88	151.89	144.84	138.00		
2.3	105.21	138.35	132.65	125.79		
2.4	94.47	125.88	121.44	114.54		
2.5	84.59	114.39	111.12	104.19		
2.6	75.49	103.79	101.62	94.66		
2.7	67.10	94.03	92.87	85.88		
2.8	59.38	85.03	84.82	77.81		
2.9	52.28	76.74	77.41	70.37		
3.0	45.73	69.09	70.59	63.52		
3.1	39.69	62.04	64.31	57.21		
3.2	34.14	55.54	58.53	51.40		
3.3	29.02	49.55	53.21	46.05		
3.4	24.30	44.02	48.31	41.13		
3.5	19.96	38.92	43.80	36.59		
3.6	15.95	34.22	39.65	32.41		
3.7	12.26	29.88	35.83	28.57		
3.8	8.86	25.87	32.31	25.02		
3.9	5.73	22.18	29.07	21.76		
4.0	2.84	18.77	26.09	18.76		
4.1	.18	15.63	23.35	15.99		
4.2	-2.27	12.73	20.82	13.44		
4.3	-4.53	10.05	18.50	11.09		
4.4	-6.62	7.58	16.36	8.93		
4.5	-8.54	5.30	14.40	6.95		
4.6	-10.31	3.20	12.59	5.12		
4.7	-11.94	1.26	10.93	3.43		
4.8	-13.44	-0.53	9.40	1.88		

PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST

RATE	ALT-PLAN 1 (ROTATION 85)	ALT-PLAN 2 (ROTATION 85)	ALT-PLAN 3 (ROTATION 85)	ALT-PLAN 4 (ROTATION 85)	ALT-PLAN 0 (ROTATION 0)	ALT-PLAN 0 (ROTATION 0)
4.9	-14.82	-2.18	7.99	.46		
5.0	-16.10	-3.71	6.70	-0.85		
5.1	-17.28	-5.11	5.52	-2.06		
5.2	-18.36	-6.41	4.43	-3.17		
5.3	-19.36	-7.61	3.43	-4.18		
5.4	-20.27	-8.71	2.52	-5.12		
5.5	-21.12	-9.73	1.68	-5.98		
5.6	-21.90	-10.66	.91	-6.77		
5.7	-22.62	-11.53	.20	-7.49		
5.8	-23.27	-12.32	-0.44	-8.15		
5.9	-23.88	-13.06	-1.03	-8.76		
6.0	-24.44	-13.73	-1.57	-9.32		
6.1	-24.95	-14.35	-2.06	-9.83		
6.2	-25.42	-14.93	-2.51	-10.29		
6.3	-25.86	-15.45	-2.92	-10.72		
6.4	-26.26	-15.94	-3.29	-11.11		
6.5	-26.62	-16.38	-3.63	-11.46		
6.6	-26.96	-16.79	-3.93	-11.78		
6.7	-27.26	-17.16	-4.21	-12.07		
6.8	-27.55	-17.50	-4.46	-12.34		
6.9	-27.80	-17.82	-4.68	-12.58		
7.0	-28.04	-18.11	-4.89	-12.80		
7.1	-28.25	-18.37	-5.07	-13.00		
7.2	-28.45	-18.61	-5.23	-13.17		
7.3	-28.63	-18.83	-5.37	-13.33		
7.4	-28.79	-19.03	-5.50	-13.47		
7.5	-28.94	-19.21	-5.61	-13.60		
7.6	-29.08	-19.37	-5.71	-13.71		
7.7	-29.20	-19.52	-5.80	-13.81		
7.8	-29.31	-19.65	-5.87	-13.90		
7.9	-29.41	-19.77	-5.93	-13.98		
8.0	-29.50	-19.88	-5.99	-14.04		
8.1	-29.58	-19.98	-6.03	-14.10		
8.2	-29.66	-20.07	-6.07	-14.15		
8.3	-29.72	-20.14	-6.09	-14.19		
8.4	-29.78	-20.21	-6.11	-14.22		
8.5	-29.83	-20.27	-6.13	-14.24		
8.6	-29.88	-20.32	-6.13	-14.26		
8.7	-29.92	-20.36	-6.13	-14.28		
8.8	-29.95	-20.40	-6.13	-14.28		
8.9	-29.98	-20.43	-6.12	-14.29		
9.0	-30.01	-20.45	-6.11	-14.29		
9.1	-30.03	-20.47	-6.09	-14.28		
9.2	-30.05	-20.49	-6.07	-14.27		
9.3	-30.06	-20.50	-6.05	-14.26		
9.4	-30.07	-20.50	-6.02	-14.24		
9.5	-30.08	-20.51	-5.99	-14.22		
9.6	-30.09	-20.50	-5.96	-14.20		
9.7	-30.09	-20.50	-5.93	-14.18		
9.8	-30.09	-20.49	-5.89	-14.15		
9.9	-30.09	-20.48	-5.85	-14.12		
10.0	-30.09	-20.47	-5.81	-14.09		

Figure 21. — Investment Analysis Program No. 6.

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                                31/32/3300 FORTRAN (2.1)/MSOS   02/02/68

      PROGRAM INVEST6                                                    INV  10
C     INVESTMENT ANALYSIS PROGRAM--DECEMBER 1967                         INV  20
C                                                                        INV  30
C     J. H. WIKSTROM                                                     INV  40
C     INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION                  INV  50
C                                                                        INV  60
C     THIS PROGRAM IS AN ADAPTATION OF CLARK ROW'S INVEST PROGRAM        INV  70
C     IT CAN BE USED WITH OR WITHOUT PRODUCT VALUES                      INV  80
C     IT HANDLES BOTH PERIODIC AND ANNUAL COSTS AND INCOMES            I INV  90
C     EXTRA CONTROL CARDS ARE NEEDED FOR PRODUCT RETURNS                 INV 100
C     FINAL VALUE IS HANDLED AS A PERIODIC INCOME                        INV 110
C                                                                        INV 120
C     PROGRAM CONTAINS 3 OPTIONS---                                      INV 130
C           GENERAL OPTION FOR INTERNAL RATE OF RETURN-PRESENT WORTH      INV 140
C           OPTION FOR STAND REPLACEMENT PRIORITIES                      INV 150
C           OPTION TO EVALUATE TIMBER STAND IMPROVEMENT ALTERNATIVES      INV 160
C                                                                        INV 170
C     RE-ROW--USFS RESEARCH PAPER  SO-6                                  INV 180
C     RE-MARTY, ETAL--USDA HANDBOOK 304                                  INV 190
C                                                                        INV 200
C                                                                        INV 210
      DIMENSION AN(6,4),CAN(6,4),NC(6,100),PECO(6,100),N1(6,100),JLD1(6, INV 220
     150),JUAL1(6,50),N2(6,100),JLD2(6,50),JUAL2(6,50),N3(6,100),JLD3(6, INV 230
     250),JUAL3(6,50),PR(3,3),CPR(3,3),FVAL(6,1),RATE(100),RTLOG(100),  INV 240
     3VALIN(6,100),FCROP(6,100),LY(6),KCX(6),K1X(6),K2X(6),K3X(6),NZ(6) INV 250
      DIMENSION NI(6,4),NT(6,4),A(12),LI(6),JX(6,10),RINT(3),NAME(20)    INV 260
      DIMENSION IDEN(20)                                                 INV 270
C                                                                        INV 280
C     FORMATS USED                                                       INV 290
C                                                                        INV 300
   10 FORMAT (8A4)                                                       INV 310
   11 FORMAT(19H1NATIONAL FOREST    ,8A4)                                INV 320
   12 FORMAT(8HOUNIT - ,8A4)                                             INV 330
   13 FORMAT(13HOATTENTION - ,8A4/1H-)                                   INV 340
   14 FORMAT(1HO,38X,44HINVESTMENT ANALYSIS PROGRAM NO.6,  INT. STA.,/)  INV 350
   15 FORMAT(19A4,2X,I2)                                                 INV 360
   16 FORMAT(15HOPROBLEM NO.    ,19A4,4X,4HID= ,I2,/1H-)                 INV 370
   17 FORMAT(20A4)                                                       INV 380
   18 FORMAT (1HO4X,20A4)                                                INV 390
   19 FORMAT(3F4.3, I2)                                                  INV 400
   20 FORMAT(1HO,44X,34HGENERAL EVALUATION OF ALTERNATIVES)              INV 410
   21 FORMAT(1HO,40X,42HEVALUATION OF STAND REPLACEMENT PRIORITIES)      INV 420
   22 FORMAT(1HO,38X,47HEVALUATION OF TIMBER STAND IMPROVEMENT PROGRAMS) INV 430
   23 FORMAT(1HO,16X,3(2X4HRINT),1X,3HJPR)                               INV 440
   24 FORMAT(17HOCONTROL CARD 6  ,3(F6.3),2X,I2)                         INV 450
   25 FORMAT(37HOCONTROL CARDS FOR FUTURE STANDS*****)                   INV 460
   26 FORMAT(38HOCONTROL CARDS FOR FIRST TSI PLAN*****)                  INV 470
   27 FORMAT(7I2,6I3,24I2)                                               INV 480
   28 FORMAT(1H016X,2HLX,6(2X,2HLI),6(3X,2HLY),2X,2HKX,1X,4HKCXX,6(1X,   INV 490
     13HKCX))                                                            INV 500
   29 FORMAT(17HMCONTROL CARD 7  ,I2,6(2X,I2),6(2X,I3),2X,I2,3X,I2,6(2X, INV 510
     1I2))                                                               INV 520
   30 FORMAT(1H015X,3HJXX,6(2X,2HJX),1X,3HNZZ,6(2X,2HNZ),1X,3HIST,2X,    INV 530
     12HMX)                                                              INV 540
   31 FORMAT(17HMCONTROL CARD 7  ,  I2,15(2X,I2))                        INV 550
   32 FORMAT(1HO,49X,24HROTATION LENGTH IN YEARS)                        INV 560
   33 FORMAT (8X,I3,5(17X,I3))                                           INV 570
   34 FORMAT(27HOPERIODIC COSTS AND INCOMES,/2X,6(14HYEAR      COST,6X)) INV 580
   35  FORMAT(6(I3,F9.2)  )                                             INV 590
   36 FORMAT (2X,6(I4,1X,F9.2,6X))                                       INV 600
   37 FORMAT(4(2I3,F8.2,F6.3))                                           INV 610
   38 FORMAT(     39HOANNUAL COSTS AND RETURNS--ALT. OR PLAN,I4)         INV 620
   39 FORMAT(10X,8H1ST YEAR,1XI3,2X,8HEND YEAR,1X,I3,2X,1H$,F9.2,2X,6HCH INV 630
     1ANGE,F7.3)                                                         INV 640
   40 FORMAT(41HONO ANNUAL COSTS OR RETURNS--ALT. OR PLAN,I4)            INV 650
   41 FORMAT(21I2)                                                       INV 660
   42 FORMAT(1H017X,4HK1XX,6(2X,3HK1X))                                  INV 670
   43 FORMAT(17HMCONTROL CARD 11 ,12(2X,I3))                             INV 680
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   44 FORMAT(1H017X,4HK2XX,6(2X,3HK2X))                                    INV 690
   45 FORMAT(1H017X,4HK3XX,6(2X,3HK3X))                                    INV 700
   46 FORMAT(14A5)                                                         INV 710
   47 FORMAT(23H0PERIODIC RETURNS FROM ,4A5)                               INV 720
   48 FORMAT(1HO,2X,6(15HYEAR YIELD QUAL,5X))                              INV 730
   49 FORMAT (6(I3,I5,I4))                                                 INV 740
   50 FORMAT(I7,I6,I5,5(I9,I6,I5))                                         INV 750
   51 FORMAT(16H0 PRODUCT PRICES)                                          INV 760
   52 FORMAT(14X,12HPRODUCT NO.1,14X,12HPRODUCT NO.2,14X12HPRODUCT NO.3,   INV 770
     1/)                                                                   INV 780
   53 FORMAT(6(F9.3))                                                      INV 790
   54 FORMAT(1HO( 8X,1H$,F9.3,2X,2HCH,F7.3))                               INV 800
   55 FORMAT(1HO7X,6(9X,9HALT-PLAN ,I2))                                   INV 810
   58 FORMAT(1H036HDISCOUNTED NET WORTH OF FUTURE CROPS)                   INV 820
   59 FORMAT(1H139HCONTROL CARDS 7* FOR PRESENT STAND*****)                INV 830
   60 FORMAT(1H048HDISCOUNTED NET WORTH OF PRESENT AND FUTURE CROPS)       INV 840
   65 FORMAT(1H1,12HPROBLEM NO. ,19A4,/)                                   INV 850
   66 FORMAT (1H0,37HINTERNAL RATE OF RETURN FOR SCHEDULE ,A4,12H IS BET   INV 860
     1WEEN ,F5.1,5H AND ,F5.1/1H ,23HWITH PRESENT WORTHS OF ,F6.2,5H AND   INV 870
     2 ,F6.2,15H RESPECTIVELY.      )                                      INV 880
   67 FORMAT(1HO,37HINTERNAL RATE OF RETURN FOR SCHEDULE ,A4,32H IS NOT    INV 890
     1INCLUDED IN THE PROBLEM.)                                            INV 900
   68 FORMAT(1HO,37HINTERNAL RATE OF RETURN FOR SCHEDULE ,A4,4H IS ,F7.    INV 910
     11/)                                                                  INV 920
   69 FORMAT(1H02X,67HPRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE    INV 930
     1RATES OF INTEREST)                                                   INV 940
   70 FORMAT (8HO   RATE,6(6X,10H(ROTATION ,I3,1H))/)                      INV 950
   72 FORMAT (1H ,F7.1,6F20.2)                                             INV 960
   75 FORMAT(1H036HDISCOUNTED NET WORTH--FIRST TSI PLAN)                   INV 970
   76 FORMAT(1H141HCONTROL CARDS 7* FOR SECOND TSI PLAN*****)              INV 980
   77 FORMAT(1H037HDISCOUNTED NET WORTH--SECOND TSI PLAN)                  INV 990
   78 FORMAT(1H044HDISCOUNTED NET WORTH OF ADDED TSI INVESTMENT)           INV1000
   99 FORMAT(23H0  ERROR IN INPUT CARDS )                                  INV1010
  610 FORMAT(1H1)                                                          INV1020
C                                                                          INV1030
C                                                                          INV1040
C                                                                          INV1050
C  READ NAME OF NATIONAL FOREST OR ORGANIZATION                            INV1060
    1 READ (60,10)(NAME(I),I=1,8)                                          INV1070
      WRITE (61,11)(NAME(I),I=1,8)                                         INV1080
C                                                                          INV1090
C  READ NAME OF UNIT                                                       INV1100
      READ(60,10)(NAME(I),I=1,8)                                           INV1110
      WRITE(61,12)(NAME(I),I=1,8)                                          INV1120
C                                                                          INV1130
C  READ NAME OF USER                                                       INV1140
      READ (60,10)(NAME(I),I=1,8)                                          INV1150
      WRITE (61,13)(NAME(I),I=1,8)                                         INV1160
      WRITE (61,14)                                                        INV1170
C                                                                          INV1180
C  READ CARD 4, PROBLEM TITLE                                              INV1190
  100 READ (60,15)(NAME(I),I=1,19),ID                                      INV1200
      GO TO (910,105)EOFCKF(60)                                            INV1210
  105 IF(NAME(1).EQ.4HNEW )1,106                                           INV1220
  106 WRITE(61,16)(NAME(I),I=1,19),ID                                      INV1230
C                                                                          INV1240
C  READ CARD 5, PROBLEM DESCRIPTION CARDS                                  INV1250
      IF(ID.GT.0)107,110                                                   INV1260
  107 DO 109  J=1,ID                                                       INV1270
      READ(60,17)(IDEN(I),I=1,20)                                          INV1280
  109 WRITE(61,18)(IDEN(I),I=1,20)                                         INV1290
C                                                                          INV1300
C  CONTROL CARD 6, INTEREST RATES AND PROGRAM OPTION                       INV1310
  110 READ(60,19)(RINT(I),I=1,3),JPR                                       INV1320
      IF (JPR-2)111,112,113                                                INV1330
  111 WRITE(61,20)                                                         INV1340
      GO TO 114                                                            INV1350
  112 WRITE(61,21)                                                         INV1360
      GO TO 114                                                            INV1370
  113 WRITE(61,22)                                                         INV1380
  114 WRITE(61,23)                                                         INV1390
      WRITE(61,24)(RINT(I),I=1,3),JPR                                      INV1400
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C                                                                       INV1410
C  READ CARD 7,  GENERAL CONTROL CARD                                  INV1420
      IF(JPR-2)1000,115,116                                             INV1430
  115 WRITE(61,25)                                                      INV1440
      GO TO 1000                                                        INV1450
  116 WRITE(61,26)                                                      INV1460
 1000 READ(60,27)   LX,(LI(L),L=1,6),(LY(L),L=1,6),KX,KCXX,(KCX(L),L=1,6 INV1470
     1),JXX,(JX(L),L=1,6),NZZ,(NZ(L),L=1,6),IST,MX                      INV1480
      WRITE(61,28)                                                      INV1490
      WRITE(61,29)LX,(LI(L),L=1,6),(LY(L),L=1,6),KX,KCXX,(KCX(L),L=1,6) INV1500
      WRITE(61,30)                                                      INV1510
      WRITE(61,31)JXX,(JX(L),L=1,6),NZZ,(NZ(L),L=1,6),IST,MX            INV1520
      WRITE(61,32)                                                      INV1530
      WRITE(61, 33) (LI(L), L=1,LX)                                     INV1540
      WRITE(61,33)(LY(L),L=1,LX)                                        INV1550
      IF (KCXX) 135,135,120                                             INV1560
  120 WRITE(61,34)                                                      INV1570
C                                                                       INV1580
C  READ CARD 8, PERIODIC COSTS AND INCOMES                              INV1590
      DO 130 KC=1,KCXX                                                  INV1600
      READ(60,35)(NC(L,KC),PECO(L,KC),L=1,6)                            INV1610
  130 WRITE(61,36)(NC(L,KC), PECO(L,KC),L=1,LX)                         INV1620
C                                                                       INV1630
C  READ CARD 9,  ANNUAL COSTS AND INCOMES                               INV1640
  135 IF (JXX) 140,140,136                                              INV1650
  136 DO 140 L=1,LX                                                     INV1660
      IF (JX(L))138,138,137                                             INV1670
  137 JXL=JX(L)                                                         INV1680
      LIL=LI(L)                                                         INV1690
      READ(60,37)(NI(L,I2),NT(L,I2),AN(L,I2),CAN(L,I2),I2=1,JXL)        INV1700
      WRITE(61,38) LIL                                                  INV1710
      WRITE(61,39)(NI(L,I2),NT(L,I2),AN(L,I2),CAN(L,I2),I2=1,JXL)       INV1720
      GO TO 140                                                         INV1730
  138 WRITE(61,40) LIL                                                  INV1740
  140 CONTINUE                                                          INV1750
C                                                                       INV1760
C  READ CARD 10,  PRODUCT EVALUATION CONTROL CARD                       INV1770
      IF (KX) 200,200,150                                               INV1780
  150 READ(60,41)K1XX,(K1X(L),L=1,6),K2XX,(K2X(L),L=1,6),K3XX,(K3X(L),  INV1790
     1L=1,6)                                                            INV1800
      WRITE(61,42)                                                      INV1810
      WRITE(61,43)K1XX,(K1X(L),L=1,6)                                   INV1820
      WRITE(61,44)                                                      INV1830
      WRITE(61,43)K2XX,(K2X(L),L=1,6)                                   INV1840
      WRITE(61,45)                                                      INV1850
      WRITE(61,43)K3XX,(K3X(L),L=1,6)                                   INV1860
C                                                                       INV1870
C  READ CARD 11,  PRODUCT NAMES                                         INV1880
      READ(60,46)(A(I),I=1,12)                                          INV1890
      IF (K1XX) 170,170,162                                             INV1900
  162 WRITE(61,47)(A(I),I= 1,4)                                         INV1910
      WRITE(61,48)                                                      INV1920
C                                                                       INV1930
C  READ CARD 12,  PRODUCT 1 RETURNS                                     INV1940
      DO 165 K1= 1,K1XX                                                 INV1950
      READ(60,49)(N1(L,K1),JLD1(L,K1),JUAL1(L,K1),L=1,6)                INV1960
  165 WRITE(61,50) (N1(L,K1),JLD1(L,K1),JUAL1(L,K1), L=1,LX)            INV1970
  170 IF(K2XX) 180,180,172                                              INV1980
  172 WRITE(61,47)(A(I),I=5,8)                                          INV1990
      WRITE(61,48)                                                      INV2000
C                                                                       INV2010
C  READ CARD 12,  PRODUCT 2 RETURNS                                     INV2020
      DO 175 K2=1,K2XX                                                  INV2030
      READ(60,49)(N2(L,K2),JLD2(L,K2),JUAL2(L,K2),L=1,6)                INV2040
  175 WRITE(61,50)(N2(L,K2),JLD2(L,K2),JUAL2(L,K2),L=1,LX)              INV2050
  180 IF (K3XX) 190,190,182                                             INV2060
  182 WRITE(61,47)(A(I), I=9,12)                                        INV2070
      WRITE(61,48)                                                      INV2080
C                                                                       INV2090
C  READ CARD 12,  PRODUCT 3 RETURNS                                     INV2100
      DO 185 K3=1,K3XX                                                  INV2110
      READ(60,49)(N3(L,K3),JLD3(L,K3),JUAL3(L,K3),L=1,6)                INV2120
  185 WRITE(61,50)(N3(L,K3),JLD3(L,K3),JUAL3(L,K3),L=1,LX)              INV2130
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  190 CONTINUE                                                                  INV2140
C                                                                               INV2150
C  READ CARD 13,  PRODUCT PRICES                                                INV2160
      WRITE(61,51)                                                              INV2170
      WRITE(61,52)                                                              INV2180
      DO 197 M=1,MX                                                             INV2190
      READ(60,53)(PR(K,M),CPR(K,M),K=1,KX)                                      INV2200
      WRITE(61,54)(PR(K,M),CPR(K,M),K=1,KX)                                     INV2210
  197 CONTINUE                                                                  INV2220
  200 CONTINUE                                                                  INV2230
C                                                                               INV2240
C     BEGIN PROCESSING DATA.                                                    INV2250
C                                                                               INV2260
      RATE(1)=RINT(1)                                                           INV2270
      DO 210 I=2,100                                                            INV2280
      IF(RATE(I-1)-RINT(3))202,203,203                                          INV2290
  202 RATE(I)=RATE(I-1)+RINT(2)                                                 INV2300
      GO TO 210                                                                 INV2310
  203 LENGTH=I-1                                                                INV2320
      IF(LENGTH-(LENGTH/2)*2)204,205,204                                        INV2330
  204 LLNGTH=(LENGTH +1)/2                                                      INV2340
      GO TO 215                                                                 INV2350
  205 LLNGTH=LENGTH/2                                                           INV2360
      GO TO 215                                                                 INV2370
  210 CONTINUE                                                                  INV2380
  215 DO 216 I=1,LENGTH                                                         INV2390
  216 RTLOG(I)=1.+RATE(I)                                                       INV2400
C                                                                               INV2410
C     DO COMPUTATIONS                                                           INV2420
C                                                                               INV2430
      IF (KX)218,218,217                                                        INV2440
  217 DO 600 M=1,MX                                                             INV2450
  218 DO 300 L=1,LX                                                             INV2460
      DO 300 I=1,LENGTH                                                         INV2470
      KCXA=KCX(L)                                                               INV2480
      K1XA=K1X(L)                                                               INV2490
      K2XA=K2X(L)                                                               INV2500
      K3XA=K3X(L)                                                               INV2510
      DAN=DCAN=0.0                                                              INV2520
      DKC= 0.0                                                                  INV2530
      DK1=DK2=DK3=0.0                                                           INV2540
      RTLOI=RTLOG(I)                                                            INV2550
      LYL= LY(L)                                                                INV2560
      DISCO=RTLOI**LYL                                                          INV2570
C                                                                               INV2580
C  COMPUTE DISCOUNTED PERIODIC COSTS AND INCOMES                                INV2590
C                                                                               INV2600
      IF (KCXX)226,226,220                                                      INV2610
  220 IF(KCXA)226,226,221                                                       INV2620
  221 DO 225 KC=1,KCXA                                                          INV2630
      KXLY=NC(L,KC)                                                             INV2640
      DISC=RTLOI ** KXLY                                                        INV2650
  225 DKC=DKC+PECO(L,KC)/DISC                                                   INV2660
C                                                                               INV2670
C  COMPUTE DISCOUNTED ANNUAL COSTS AND INCOMES                                  INV2680
C                                                                               INV2690
  226 IF (JXX)240,240,230                                                       INV2700
  230 IF (JX(L))240,240,231                                                     INV2710
  231 JXL=JX(L)                                                                 INV2720
      DO 240 I2=1,JXL                                                           INV2730
      NTL=(NT(L,I2)-NI(L,I2))                                                   INV2740
      NIL= NI(L,I2)                                                             INV2750
      IF(AN(L,I2))232,240,232                                                   INV2760
  232 SISCO= RTLOI**NTL                                                         INV2770
      FISCO= RTLOI**NIL                                                         INV2780
      BBN=(AN(L,I2)*(SISCO-1.))/(RATE(I)*SISCO)                                 INV2790
      IF(NIL.GT.0)233,234                                                       INV2800
  233 BAN=(BBN/(RATE(I)*FISCO))                                                 INV2810
      GO TO 235                                                                 INV2820
  234 BAN= BBN                                                                  INV2830
  235 DAN= DAN + BAN                                                            INV2840
      IF(CAN(L,I2)) 236,240,236                                                 INV2850
  236 CCAN=(CAN(L,I2)*AN(L,I2)*(SISCO-NTL * RATE(I)-1.))/(RATE(I)**2*SISCO      INV2860
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     1)                                                                 INV2870
      IF(NIL.GT.0) 237,238                                              INV2880
  237 BCAN=(CCAN/(RATE(I)*FISCO))                                       INV2890
      GO TO 239                                                         INV2900
  238 BCAN= CCAN                                                        INV2910
  239 DCAN= DCAN + BCAN                                                 INV2920
  240 CONTINUE                                                          INV2930
C                                                                       INV2940
C  COMPUTE DISCOUNTED PRODUCT VALUES                                    INV2950
C                                                                       INV2960
      IF (KX)280,280,250                                                INV2970
  250 IF (K1XA) 260,260,251                                             INV2980
  251 DO 255 K1=1,K1XA                                                  INV2990
      KXLY=N1(L,K1)                                                     INV3000
      QUAL1=JUAL1(L,K1) * .01                                           INV3010
      DISC=RTLOI ** KXLY                                                INV3020
      YLD1=JLD1(L,K1) * .1                                              INV3030
  255 DK1=DK1+(YLD1*PR(1,M)*QUAL1*(1.+CPR(1,M)*N1(L,K1))/DISC)          INV3040
  260 IF (K2XA)270,270,261                                              INV3050
  261 DO 265 K2=1,K2XA                                                  INV3060
      KXLY=N2(L,K2)                                                     INV3070
      DISC=RTLOI ** KXLY                                                INV3080
      QUAL2=JUAL2(L,K2) * .01                                           INV3090
      YLD2=JLD2(L,K2) * .1                                              INV3100
  265 DK2=DK2+(YLD2*PR(2,M)*QUAL2*(1.+CPR(2,M)*N2(L,K2))/DISC)          INV3110
  270 IF(K3XA)280,280,271                                               INV3120
  271 DO 275 K3=1,K3XA                                                  INV3130
      KXLY=N3(L,K3)                                                     INV3140
      DISC=RTLOI ** KXLY                                                INV3150
      QUAL3=JUAL3(L,K3) * .01                                           INV3160
      YLD3=JLD3(L,K3) * .1                                              INV3170
  275 DK3=DK3+(YLD3*PR(3,M)*QUAL3*(1.+CPR(3,M)*N3(L,K3))/DISC)          INV3180
C                                                                       INV3190
C  SUMMARIZE (FILL VALIN ARRAY)                                         INV3200
C                                                                       INV3210
  280 IF (NZZ)295,295,290                                               INV3220
  290 IF (NZ(L))295,295,292                                             INV3230
  292 TDVAL=DK1+DK2+DK3+ DAN+ DCAN+ DKC                                 INV3240
      VALIN(L,I)=TDVAL                                                  INV3250
      GO TO 300                                                         INV3260
  295 TDVAL=DK1+DK2+DK3+ DAN+ DCAN+DKC                                  INV3270
      VALIN(L,I)=TDVAL*( 1.+ 1. /(DISCO-1.))                            INV3280
  300 CONTINUE                                                          INV3290
C                                                                       INV3300
      IF (JPR-2)303,302,301                                             INV3310
  301 GO TO 400                                                         INV3320
  302 GO TO 350                                                         INV3330
  303 CONTINUE                                                          INV3340
C                                                                       INV3350
C  COMPLETE OUTPUT FOR GENERAL OPTION                                   INV3360
C                                                                       INV3370
      WRITE(61,65) (NAME(I),I=1,19)                                     INV3380
      DO 304 I=1,LENGTH                                                 INV3390
      RATE (I)= RATE(I)*100.0                                           INV3400
  304 CONTINUE                                                          INV3410
      DO 320 L=1,LX                                                     INV3420
      DO 310 I=1,LENGTH                                                 INV3430
      IF (VALIN(L,I).GT.0.0)310,305                                     INV3440
  305 IF (VALIN(L,I).EQ.0.0)308,306                                     INV3450
  306 IF (I.EQ.1)311,307                                                INV3460
  307 WRITE(61,66)LI(L),RATE(I-1),RATE(I),VALIN(L,I-1),VALIN(L,I)       INV3470
      GO TO 320                                                         INV3480
  308 WRITE(61,68) LI(L),RATE(I)                                        INV3490
      GO TO 320                                                         INV3500
  310 CONTINUE                                                          INV3510
  311 WRITE(61,67)     LI(L)                                            INV3520
  320 CONTINUE                                                          INV3530
      WRITE(61,69)                                                      INV3540
      WRITE(61,55)(LI(L),L=1,6)                                         INV3550
      WRITE(61,70) (LY(L),L=1,6)                                        INV3560
      DO 321 I=1,LENGTH                                                 INV3570
      WRITE(61,72)RATE(I),(VALIN(L,I),L=1,LX)                           INV3580
  321 CONTINUE                                                          INV3590
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      DO 325 I=1,LENGTH                                                 INV3600
      RATE (I)=RATE(I)/100.0                                            INV3610
  325 CONTINUE                                                          INV3620
      GO TO 600                                                         INV3630
C                                                                       INV3640
C  CONTINUE WITH PROGRAM OPTION 2                                       INV3650
C                                                                       INV3660
  350 IF(IST.EQ.1)351,360                                               INV3670
  351 DO 355 L=1,LX                                                     INV3680
      DO 355 I=1,LENGTH                                                 INV3690
  355 FCROP(L,I)=VALIN(L,I)                                             INV3700
      VALIN(L,I)=0.0                                                    INV3710
      WRITE(61,65) (NAME(I),I=1,19)                                     INV3720
      WRITE(61,58)                                                      INV3730
      DO 356 I=1,LENGTH                                                 INV3740
  356 RATE (I)=RATE(I)*100.0                                            INV3750
      WRITE(61,55)(LI(L),L=1,6)                                         INV3760
      WRITE(61,70)(LY(L),L=1,6)                                         INV3770
      DO 357 I=1,LENGTH                                                 INV3780
      WRITE (61,72) RATE(I),(FCROP(L,I),L=1,LX)                         INV3790
  357 CONTINUE                                                          INV3800
      DO 358 I=1,LENGTH                                                 INV3810
      RATE (I)= RATE(I)/100.0                                           INV3820
  358 CONTINUE                                                          INV3830
      WRITE(61,59)                                                      INV3840
      GO TO 1000                                                        INV3850
  360 DO 361 L=1,LX                                                     INV3860
      DO 361 I=1,LENGTH                                                 INV3870
      LYL=LY(L)                                                         INV3880
      DISCO=RTLOG(I)**LYL                                               INV3890
      VALIN(L,I)=VALIN(L,I)+( FCROP(L,I) /DISCO)                        INV3900
  361 CONTINUE                                                          INV3910
      WRITE(61,65) (NAME(I),I=1,19)                                     INV3920
      WRITE(61,60)                                                      INV3930
      DO 362 I=1,LENGTH                                                 INV3940
      RATE (I)=RATE (I)*100                                             INV3950
  362 CONTINUE                                                          INV3960
      WRITE(61,55)(LI(L),L=1,6)                                         INV3970
      WRITE(61,70)(LY(L),L=1,6)                                         INV3980
      DO 363 I=1,LENGTH                                                 INV3990
      WRITE(61,72) RATE(I),(VALIN(L,I),L=1,LX)                          INV4000
  363 CONTINUE                                                          INV4010
      GO TO 600                                                         INV4020
  400 CONTINUE                                                          INV4030
C                                                                       INV4040
C  CONTINUE WITH PROGRAM OPTION 3                                       INV4050
C                                                                       INV4060
      IF (IST.EQ.1)401,410                                              INV4070
  401 DO 402 L=1,LX                                                     INV4080
      DO 402 I=1,LENGTH                                                 INV4090
  402 FCROP(L,I)=VALIN(L,I)                                             INV4100
      VALIN(L,I)=0.0                                                    INV4110
      WRITE(61,65) (NAME(I),I=1,19)                                     INV4120
      WRITE(61,75)                                                      INV4130
      DO 403 I=1,LENGTH                                                 INV4140
  403 RATE(I)=RATE(I)*100.0                                             INV4150
      WRITE(61,55)(LI(L),L=1,6)                                         INV4160
      WRITE(61,70)(LY(L),L=1,6)                                         INV4170
      DO 404 I=1,LENGTH                                                 INV4180
      WRITE(61,72) RATE(I),(FCROP(L,I),L=1,LX)                          INV4190
  404 CONTINUE                                                          INV4200
      DO 405 I=1,LENGTH                                                 INV4210
      RATE(I)=RATE(I)/100.0                                             INV4220
  405 CONTINUE                                                          INV4230
      WRITE(61,76)                                                      INV4240
      GO TO 1000                                                        INV4250
  410 CONTINUE                                                          INV4260
      WRITE(61,65) (NAME(I),I=1,19)                                     INV4270
      WRITE(61,77)                                                      INV4280
      DO 411 I=1,LENGTH                                                 INV4290
  411 RATE(I)=RATE(I)*100.0                                             INV4300
      WRITE(61,55)(LI(L),L=1,6)                                         INV4310
      WRITE(61,70)(LY(L),L=1,6)                                         INV4320
```

```
      DO 412 I=1,LENGTH                                                  INV4330
      WRITE(61,72) RATE(I),(VALIN(L,I),L=1,LX)                           INV4340
  412 CONTINUE                                                           INV4350
      WRITE(61,65) (NAME(I),I=1,19)                                      INV4360
      WRITE(61,78)                                                       INV4370
      DO 413 L=1,LX                                                      INV4380
      DO 413 I=1,LENGTH                                                  INV4390
  413 VALIN(L,I)=VALIN(L,I)-FCROP(L,I)                                   INV4400
      WRITE(61,55)(LI(L),L=1,6)                                          INV4410
      WRITE(61,70) (LY(L),L=1,6)                                         INV4420
      DO 415 I=1,LENGTH                                                  INV4430
      WRITE(61,72) RATE(I),(VALIN(L,I),L=1,LX)                           INV4440
  415 CONTINUE                                                           INV4450
      GO TO 600                                                          INV4460
  600 CONTINUE                                                           INV4470
      VALIN(L,I)=0.0  $FCROP(L,I)=0.0                                    INV4480
      WRITE(61,610)                                                      INV4490
C  READ CARD 12,END OF PROBLEM                                           INV4500
      READ(60,27)IEND                                                    INV4510
      IF(IEND-98)900,100,910                                             INV4520
  900 WRITE(61,99)                                                       INV4530
  910 STOP                                                               INV4540
      END                                                                INV4550
```

3200 FORTRAN DIAGNOSTIC RESULTS - FOR INVEST6

Wikstrom, J. H., and Jack R. Alley.
1968. Ranking treatment opportunities in existing timber stands on white pine land in the Northern Region. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta., Ogden, Utah. 75 pp., illus. (U.S. Forest Serv. Res. Pap. INT-46)

Economic evaluation of alternative ways of treating timber stands to increase timber production is a basic step toward efficient use of timber growing funds.

The considerations in such an evaluation are discussed in relation to management of white pine land, and sample problems are presented. An EDP investment analysis program containing options usable in ranking stand replacement and timber stand improvement priorities is given, along with instructions for use.

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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Project headquarters are also at:

Boise, Idaho
Bozeman, Montana (in cooperation with Montana State University)
Logan, Utah (in cooperation with Utah State University)
Missoula, Montana (in cooperation with University of Montana)
Moscow, Idaho (in cooperation with the University of Idaho)
Provo, Utah (in cooperation with Brigham Young University)

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